5001 TRANSISTORIZED DIGITAL VOLTMETER MODEL 26.158

EAI

ELECTRONIC ASSOCIATES INC. ■ LONG BRANCH, NEW JERSEY

EAI®

ELECTRONIC ASSOCIATES, INC. *Long Branch, New Jersey*

5001 TRANSISTORIZED DIGITAL VOLTMETER MODEL 26.158

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AI-14	37	Add Item 37 as follows: R30,R31 - Resistor, Fixed, Composition: 1 K ohm ±5%, 1/4W; Allen-Bradley CB-EAI 625 102 0-- A Category
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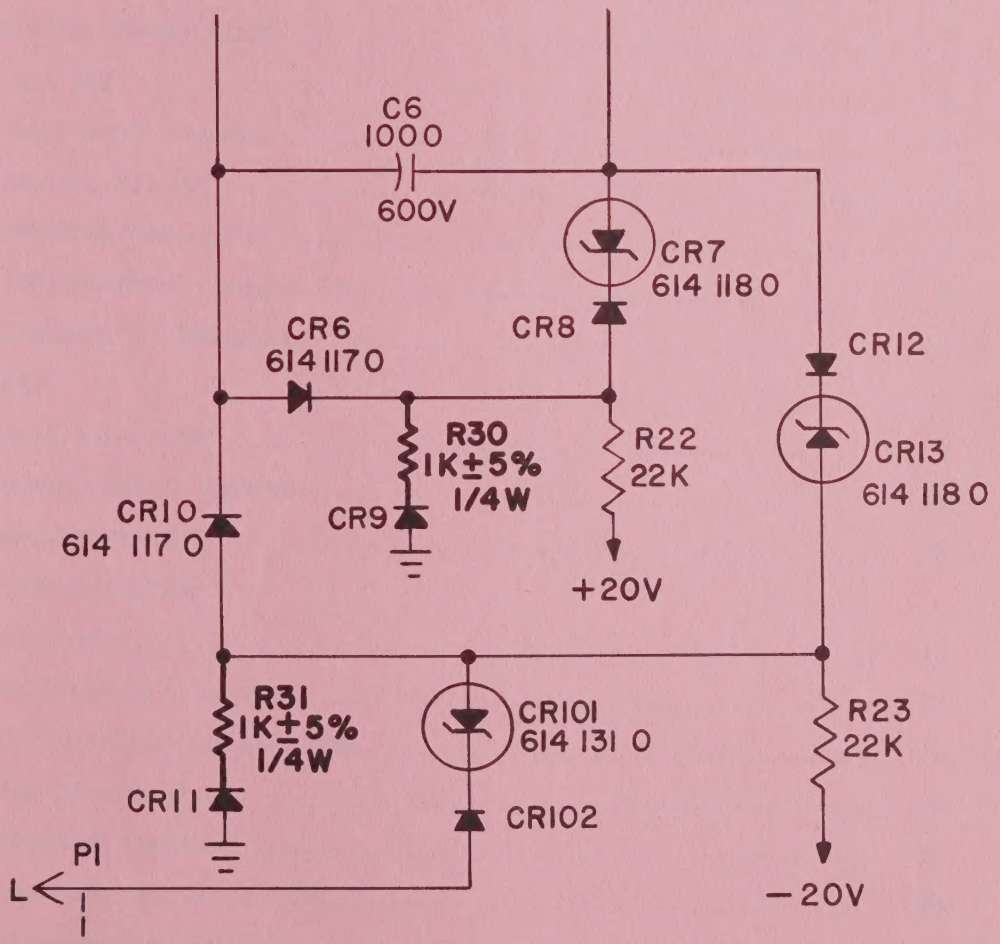

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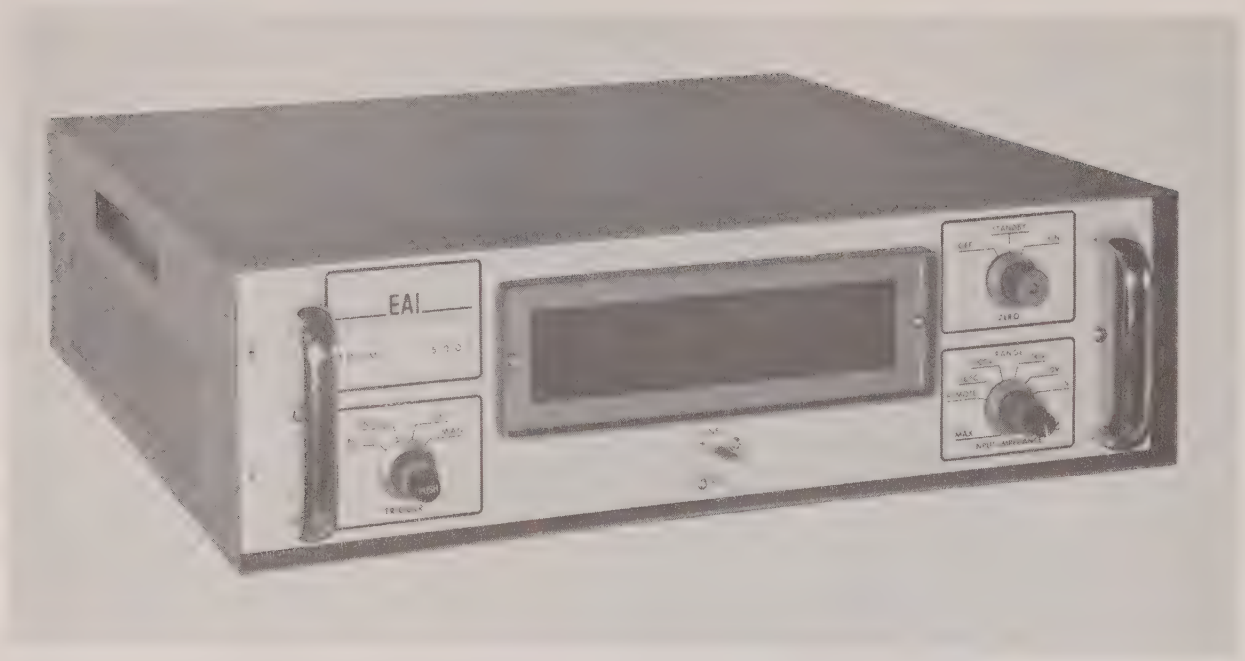


Front View

Rear View

Figure 1. 5001 Transistorized Digital Voltmeter (With Dust Cover)

CHAPTER I

GENERAL DESCRIPTION

1. FUNCTION

The 5001 Transistorized Digital Voltmeter (TDVM), designed and manufactured by EAI (Electronic Associates, Inc.) is a fast acting, high precision instrument for d-c voltage measurement. This instrument (Figures 1 and 2) features both automatic and manual range selection with overload protection when operated in the manual range-selection mode. The readout is presented on a high-brilliance optical readout system which permits wide angle viewing even under adverse ambient light conditions. Readout representation of the measured potential is presented as a five-digit decimal display plus the polarity sign and decimal point.

The 5001 TDVM presents *full-time* input impedance to the input source; this input impedance is not dependent on a *null* condition of the TDVM. This feature eliminates variable loading of the input voltage source during the TDVM sampling cycle. The 5001 samples and reads out the unknown potential on the average of 200 readings per second (without a sign change or change in TDVM range).

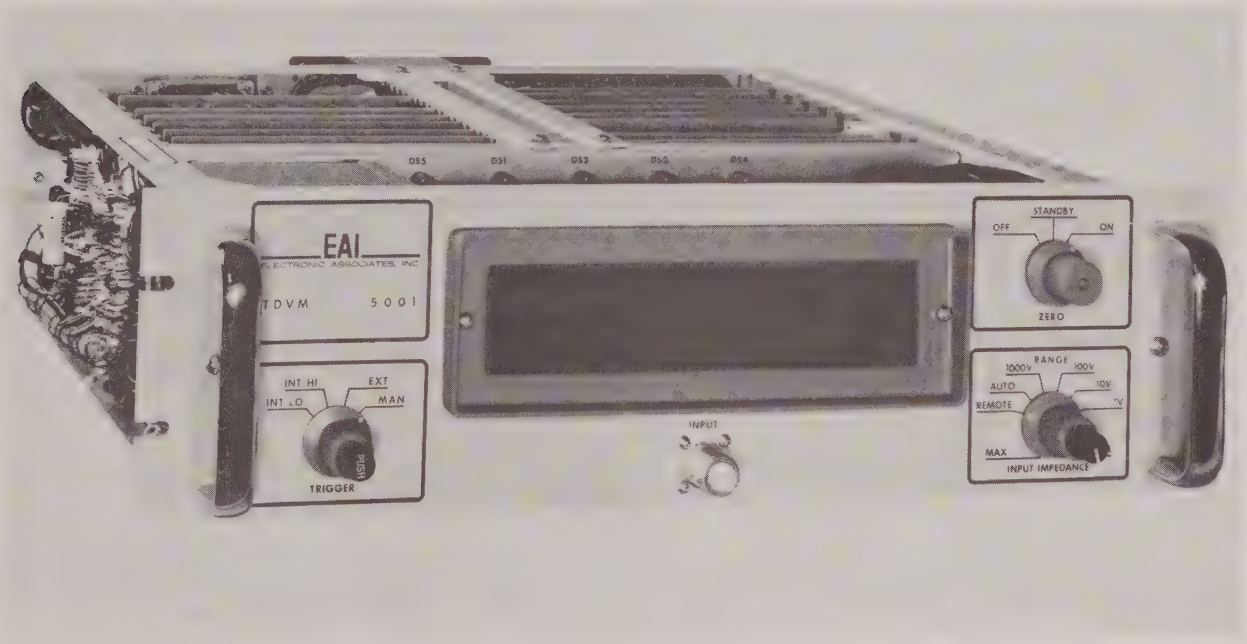


Figure 2. 5001 TDVM as Furnished for Rack Mounting

The 5001 TDVM is capable of accurately measuring voltages from zero to 1000 volts (plus 20% over range) in four ranges: 0 to 1 volt, 0 to 10 volts, 0 to 100 volts, and 0 to 1000 volts. Input impedance ranges from 250 megohms (or greater) on the 1 volt range and 500 megohms (or greater) on the 10 volt range, to 10 megohms on the 100 and 1000 volt ranges. A switch is provided for the 1 and 10 volt ranges which permits setting the impedance to 10 megohms. This feature is incorporated to provide equal loading to input signals in all four of the TDVM ranges. Comparative readings of greater accuracy with respect to each readout range are therefore available to the operator.

Increased flexibility of the TDVM usage is provided by supplying output signals (in both straight decimal and binary-coded decimal form) representing the voltage being measured. These signals are terminated at a connector on the rear of the TDVM chassis to facilitate their usage in driving such external equipment as a remote visual indicator, a card or tape punch, or a high-speed printer.

The TDVM, by using a programmed-comparision type of meter circuit and utilizing transistorized circuitry throughout (thus eliminating stepper switches), provides quiet, reliable, accurate, and long-term trouble-free operation. Easily adjusted controls assure high accuracy over extended field use. Interchangeability of many of the printed circuit cards aids in maintenance and repair of the instrument.

The 5001 TDVM features a floating ground system which permits the measurement of the d-c potential difference between two voltage sources.

2. PHYSICAL DESCRIPTION

The 5001 TDVM is designed for use as either a rack-mounted (Figure 2) or portable bench instrument. All components are contained (including power supplies and stable reference source) in a 19-inch chassis compatible with standard RETMA rack requirements.

A majority of the TDVM components (with exception of the power supplies and certain networks) are mounted on removable printed-circuit cards that plug into chassis-mounted connectors. Table I lists the various printed circuit cards, the circuit designation, and the chassis-mounted connector designation. The physical location of each card is shown in Figures 3 and 4.

TABLE I

CARD NOMENCLATURE	MODEL NUMBER	QUANTITY REQUIRED	CIRCUIT AND CHASSIS CONNECTOR DESIGNATION
Dual D.C. Amplifier	6.463-1	1	AR1-J1
Reference Amplifier	6.464-4	1	AR2-J1
Comparator and Diode Gate	26.096-3	1	A1-J1
Binary Coded Decade Counter	44.139-4	1	A2-J1 (1000's)
Binary Coded Decade Counter	44.139	3	A3-J1 (100's) A4-J1 (10's) A5-J1 (1's)
Programmer	44.170-4	1	A6-J1
Readout Storage Decade	51.010	3	A7-J1 (1's) A8-J1 (10's) A9-J1 (100's)
Readout Storage Decade	51.080-5	1	A10-J1 (1000's)
Auto Range Switching	14.156-1	1	A11-J1
Summing Resistor Network	26.116-1	1	NW2-J1
Miscellaneous Network Card	12.1064	1	NW7-J1
Power Supply Regulator	43.126-1	1	VR1-J1

In addition to the plug in cards, certain other components are in the form of network assemblies mounted on the TDVM. These units are listed in Table II.

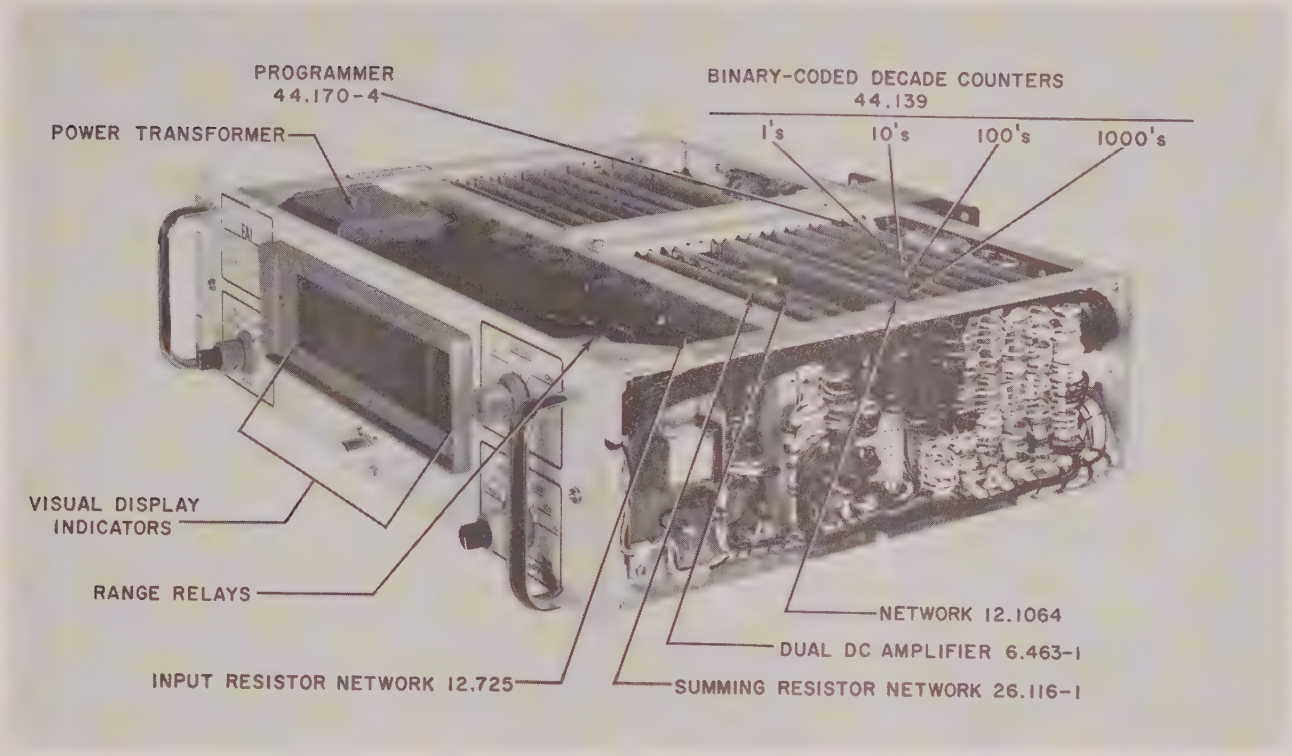


Figure 3. Chassis Component Location (Front View

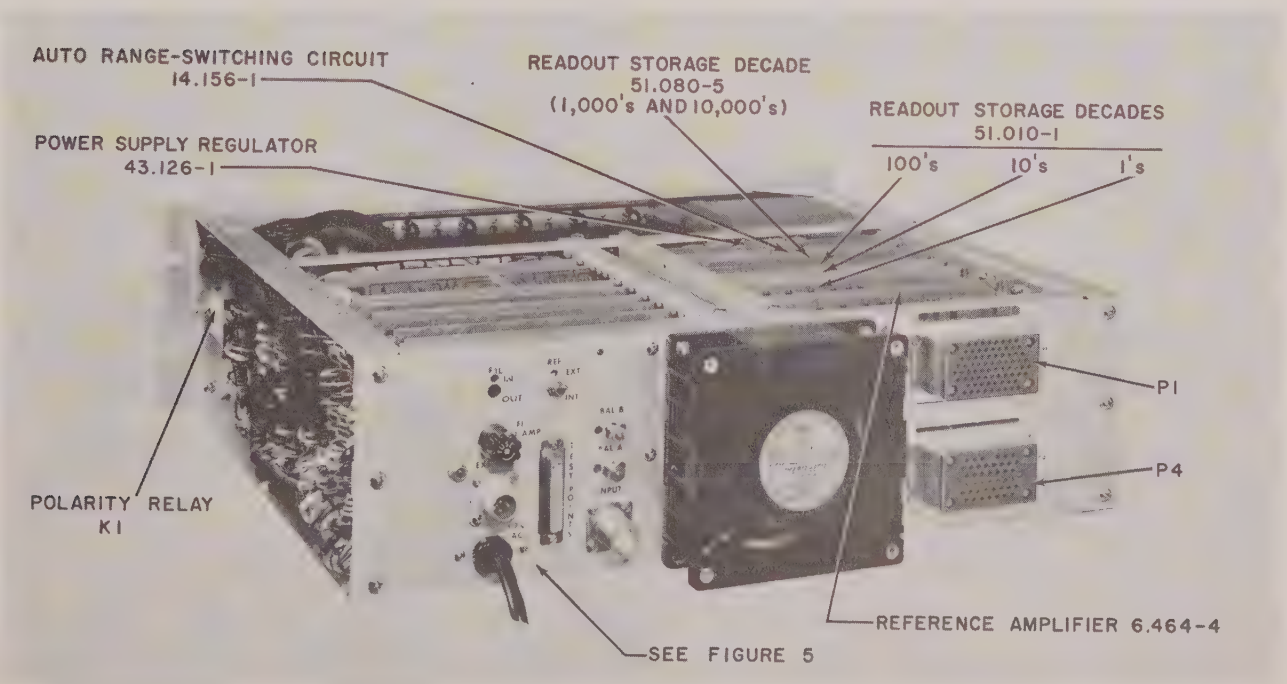


Figure 4. Chassis Component Location (Rear View)

TABLE II

NETWORK NOMENCLATURE	MODEL NO.	QUANTITY	CHASSIS DESIGNATION
Rectifier Network	12.675	1	NW8
Reference Amplifier Network	12.722	1	NW6
Input Resistor Network	12.725	1	NW1

Table III lists the physical dimensions of the TDVM.

TABLE III

CHASSIS (overall)	5-1/4 x 19 inch RETMA Panel 16 inches deep
COVER (overall)	Height ..... 6-1/4 inches Width ..... 19-1/4 inches Depth ..... 17-1/8 inches
WEIGHT	Chassis only ..... 25 pounds Chassis and cover ..... 40 pounds

3. TDVM ACCESSORY GROUPS

a. Accessory Installation Group 2.393

The Accessory Installation Group 2.393 provides the dust cover and necessary hardware for TDVM Model 26.158 if desired to use the TDVM as a portable bench instrument (Figure 1).

b. Accessory Installation Group 2.394

The Accessory Installation Group 2.394 provides the necessary hardware for TDVM Model 26.158 if desired to rack mount the instrument (Figure 2).

4. TECHNICAL DATA AND SPECIFICATIONS

Ranges (Automatic or Manual Selection) ..... 0 to 1 volt +20% over range = 0 to 1.1999 volts

0 to 10 volts +20% over range = 0 to 11.999 volts

0 to 100 volts +20% over range = 0 to 119.99 volts

0 to 1000 volts +20% over range = 0 to 1199.9 volts

Input Impedance ..... Dependent on Range

Range	Impedance (Megohms)
1 volt	250 minimum*
10 volt	500 minimum*
100 volt	10
1000 volt	10

Maximum Readout Time ..... 0.35 seconds (automatic change of range, no polarity change)

0.7 second (both range and polarity change)

0.01 second (no change in either polarity or range)

Conversion Time ..... 0.005 seconds average**

Accuracy ..... ±0.01% of full scale ±1 digit on all ranges

Resolution of Digital Presentation ..... 0.01% of full scale

Power Requirements ..... 115/230 volts, 50/60 cycles

Rated Operating Temperature ..... 55°F to 100°F

Temperature Coefficient ..... Readout change of 0.0005% per °F typical

Polarity Indicator ..... automatic

Range Switching ..... automatic, manual, or remote

Input ..... double ended

Trigger ..... internal, manual or external

The input impedance of the 1 and 10 volt ranges with careful adjustment may be set to even higher values. The INPUT IMPEDANCE switch also permits setting the impedance of these ranges to 10 megohms to agree with the 100 and 1000 volt ranges.

***The unknown input is sampled continuously at an average rate of 200 samples per second.*

CHAPTER II

INSTALLATION AND ADJUSTMENTS

1. CHASSIS INSTALLATION

As previously indicated the 5001 TDVM is designed for use as a bench instrument or for mounting in a standard 19-inch RETMA rack. Instruments for bench use are shipped in the heavy-duty dust cover and require no installation other than the external connections (if desired) described in Paragraph 2 of this chapter.

Unpack the TDVM from the shipping carton, and check that all components are in place and undamaged. The unit may be removed from the dust cover by removing the four screws which fasten the dust cover to the front panel (one in each corner of the front panel) and two bottom screws and sliding the chassis forward.

If the TDVM is to be rack mounted, the front panel should be fastened to the rack by running four screws (1/4-20 screws for an EAI rack and 10-32 screws for a standard RETMA rack) through the slotted holes on each side of the panel.

Secure these screws tightly. Although the TDVM chassis is sufficiently strong to permit rack-mounting without supporting the rear of the chassis, it is recommended that rear supports or side rails be installed in the rack. This will make the chassis easier to handle when removing the unit from the rack.

2. A.C. POWER CONNECTION

The 5001 TDVM is equipped with a standard 3-wire power cable for connection to a single-phase 115/230 volt source. If the power source is not wired for the 3-prong plug an adaptor is required. *If the adaptor is used, the green ground lead on the adaptor must be connected to an earth ground.* Also, check the polarization of the a-c line to be certain that the TDVM *hot* a-c lead (black) is connected to the *hot* side of the source.

The TDVM is designed for use with either 50 or 60-cycle power sources at 115 or 220 volts. Drawing D026 158 0S, Sheet 4, shows the unit wired for 115 volt operation. For 220 volt operation the following operations must be performed:

a. Remove jumper between T1-2a and T1-1.

b. Remove the T1-2c end of the jumper between T1-2c and T1-2b and reterminate at T1-2a.

c. Change fuse F1 from 1 ampere to 3/4 ampere (indicate change in lettering next to fuse).

d. Change 117 VAC lettering to 220 VAC next to power cable at rear of unit.

3. EXTERNAL CONNECTIONS

Several connectors are mounted on the rear of the TDVM chassis to provide for certain external control functions and electrical outputs. These connectors and their functions are listed in the following paragraphs.

a. EXT REF

This coaxial connector permits slaving the TDVM reference circuits to an external reference source of -100 volts. The adjacent switch (EXT/INT) provides selection of the reference source.

b. TEST POINT Connector

To facilitate adjustment and maintenance of the TDVM certain input and output points are wired to a connector on the rear of the TDVM (TEST POINT connector P2). These points include all power supply outputs, amplifier outputs, and some logic-switching voltages. The TEST POINT data may be used directly at the connector, or may be cabled to a central monitoring facility. (See Table VI, Chapter V.) The mating plug for connector P2 is Connector, Plug, EAI 542 098 0; Cannon Electric Co. DB-25P.

In addition, the terminals for balancing the two d-c amplifiers are terminated at the TEST POINT connector. The amplifier balance procedure is covered in Chapter III.

c. INPUT Connector

This coaxial jack (J3) is wired in parallel with the front panel connector.

d. Printer Connector P1

This 78-pin connector provides output signals and control functions to drive remote indicating devices, tape or card punches, or a printer. The following table describes the available outputs. (See Sheets 16 and 17 of Drawing B026 158 0W for a complete list of PRINTER connector terminations.) The mating plug for connector P1 is Connector, Plug, EAI 542 122 0; Cannon Electric Co. DPD-78-33P-1L.

TABLE IV

DATA OUTPUTS		
TYPE OF OUTPUT	FUNCTION	ELECTRICAL CHARACTERISTICS
Binary-Coded Decimal	1, 2, 4, 8 per each decade counter	-6 volts indicates presence of digit, -0.5* volts indicates absence of digit. Source impedance of each line is about 2700 ohms.
Decimal	0-9 per each decade counter	-7.5 volts indicates absence of digit, -1 volt* indicates presence of digit. Each source can provide up to 1 MA of load current.
Decimal Position (Range Indication)	1, 10, 100 or 1000 volt range	-7.5 volts indicates meter not in particular range, -1 volt indicates meter is in this range. (Terminals P1-43 through P1-46; see Sheet 3 of D026 158 0S.)
Polarity Indication	+, -	-1 volt indicates input signal polarity (other polarity lead at -7.5 volts). (Terminals P1-70 and P1-71; see Sheet 3 of D026 158 0S.)
Finish-Reading Pulse (Indicator-clear)	Indicates decimal and BCD outputs set to new readings	200 microsecond positive-going pulse (from -7.5 volts to approximately -0.5* volts). Terminal P1-69.

**Refers to saturated transistor.*

e. Programming Connector P4

This connector is provided to facilitate external command control of the TDVM. Functions such as range control and cycle command can be operated from a remote location. See Drawing B026 158 0W, Sheet 19 for a complete list of the PROGRAMMING connector terminations. The mating plug for connector P4 is Connector, Plug, EAI 542 120 0; Cannon Electric Co. DPD-45-34P-1L.

4. PRELIMINARY ADJUSTMENTS

Each TDVM is completely checked and factory-calibrated prior to shipment and should require no further adjustment upon receipt. A pre-operational check procedure is outlined in Paragraph 2, Chapter III of this handbook. Performing this check will enable the operator to determine that the instrument is operating properly. If trouble is encountered, refer to appropriate paragraphs in the chapters describing TDVM maintenance and calibration.

CAUTION

Calibration adjustments should not be performed unless the operator is certain that the instrument is out of calibration. Calibration of an instrument with the accuracy of the TDVM is a relatively difficult procedure, requiring the use of precision voltage sources and measuring facilities not normally available in field installations.

2. PRE-OPERATIONAL CHECKS

The procedures outlined in this paragraph are recommended for use as a pre-operational check and for periodic preventive maintenance purposes after the instrument is in service. These checks are relatively simple to perform and serve to indicate that the instrument is functioning properly. (If trouble is encountered refer to appropriate sections of this handbook for maintenance and calibration procedures.)

a. Prepare the TDVM for operation by connecting the power cord to an appropriate a-c source. Set the power switch to STANDBY and permit the instrument to warm up for 30 minutes.

Periodically when turning the TDVM on, especially if just previously turned off, or if operating in an ambient temperature close to 100° F, the instrument may "lock" with a fixed readout. This may be rectified by turning the instrument off, waiting 30 to 60 seconds and turning the unit back on. (The cause is the inhibit flip-flop, which although unbalanced in design, may start in the *set* position instead of *reset*.)

If the instrument has been on and is turned off, allow one minute before turning the unit on again.

The "locked" condition should not be confused with the normal settling of the d-c amplifier when the unit is initially turned on. If the sign indication changes at initial turn on (overload lamp also lit) the unit is functioning and the amplifiers will settle within approximately 30 seconds. (In the 10 and 1 volt ranges, due to the unloading circuit, the readout will appear to drift with no input signal.)

b. Connect a multimeter (Triplett, Model 630A or equivalent, set to read d-c voltage) between pins 16 (±ground) and 17 of the TEST POINT connector. Rotate the BAL-B potentiometer for a zero voltage reading on the 3-volt range; the zero reading on this voltage range is sufficient for accurate TDVM operation.

CAUTION

Relatively high levels of voltage may be generated as the BAL control is rotated. Use higher voltage ranges first, reducing the range to the 3-volt range as the voltage null is approached.

c. Repeat step *b.* connecting the meter between pins 16 and 18 and adjusting the BAL-A potentiometer.

d. Set the RANGE switch in the 10 volt position and rotate the ZERO control until the indicators display 00000. (If the polarity relay begins to chatter turn the ZERO control slightly *clockwise* until the chatter stops and the indicator displays 00000.)

e. Connect a low-level variable d-c voltage source (capable of supplying potentials of 0 to ±12 volts) to the input connector; set the TDVM RANGE switch to the AUTO position. *(The d-c source must be stable.)*

f. Set the d-c source for a positive output of less than 1 volt. Slowly vary the input voltage and check for proper counting sequence. Make sure that the digits in each decade are displayed in proper order and that the TDVM switches ranges when the input is raised above 1.1999 and 11.999 volts. Reverse the input polarity; observe that the polarity indicator changes.

g. Connect a high-level, variable d-c voltage source to the input connector. Alternately apply inputs of 90 and 500 (or at least 120) volts of each polarity; check for proper ranging and polarity indication.

h. Manually switch the instrument to the 10 volt range. Apply a positive or negative potential voltage of less than 10 volts to the TDVM and slowly increase this potential. Observe that the overload lamp starts to flicker as the input raises above 11.999 volts.

If the TDVM operates as described in the preceding steps and no troubles are encountered, the instrument is ready for service.

3. NORMAL OPERATION

Normal operation of the 5001 TDVM is relatively simple using the three dual front panel controls previously described. The only precaution to observe is when the TDVM range is manually selected; overload voltages of *500 volts* (or greater) applied to the instrument when on *either* the *1 or 10 volt ranges* may *permanently* damage the precision input resistor network. Since this unit is sealed, field repair is not possible and the network will have to be returned to EAI for repair or replacement.

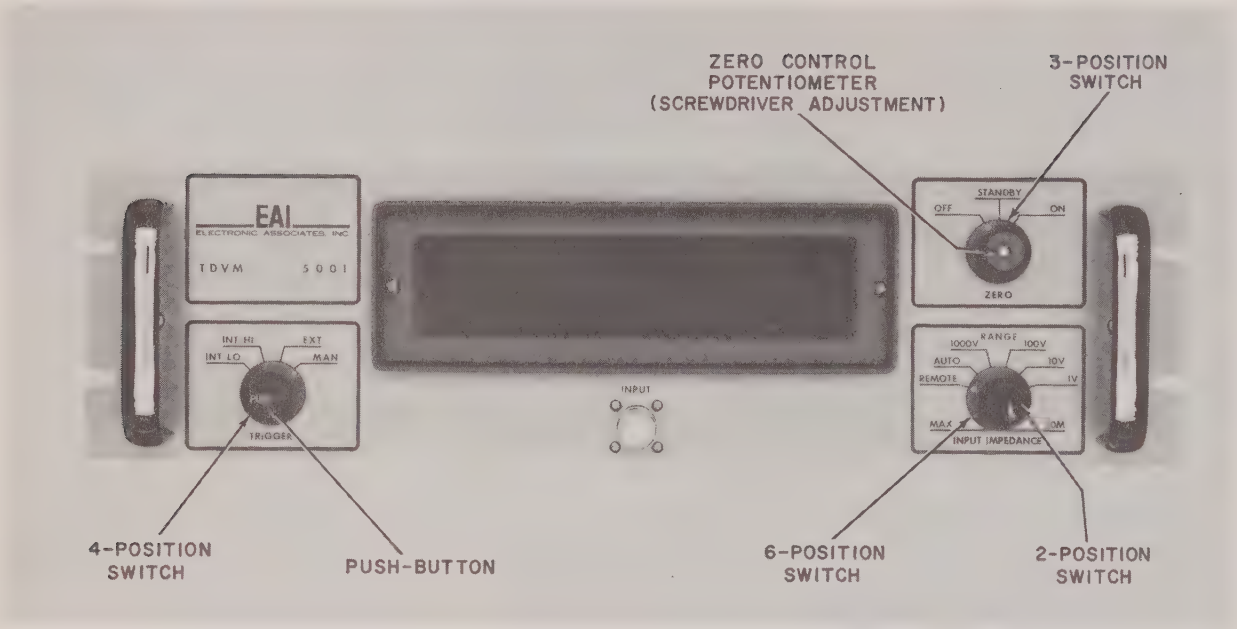
CHAPTER III

OPERATION

1. CONTROL FUNCTIONS

When using the TDVM the operator should be thoroughly familiar with all controls. Before operation, study the function of each control as described in the following table. (The first three controls listed are on the front panel; all others are rear-panel mounted. See Figure 5.)

CONTROL	FUNCTION
OFF-STANDBY-ON and ZERO control	The outer light-colored portion of this dual control is the OFF-STANDBY-ON, three-position power control selector. In the STANDBY position the input circuits remain open, but all power supplies are energized. The instrument is therefore ready for instantaneous operation by placing the switch in the ON position. In the ON position, in addition to maintaining the power supplies energized, the INPUT jacks are connected to the input amplifier and the 1 and 10 volt range unloading circuits are also connected to the input amplifier. The ZERO control is a screw driver adjustment located in the center of the OFF-STANDBY-ON control. This control permits zero-setting of the indicators
RANGE and INPUT IMPEDANCE Control	The outer light-colored portion of this dual control is the RANGE switch. The REMOTE position permits remote *manual* range selection or switching of the instrument into *automatic* selection from a remote position. The AUTO position switches the instrument into the automatic range selection mode. The remaining four positions are for manual selection of the desired range. The inner dark portion of the control is a two-position INPUT IMPEDANCE switch used in conjunction with the 1 and 10 volt ranges. In the MAX position the instrument offers maximum impedance on the 1 and 10 volt ranges; in the 10M position the 1 and 10 volt range impedances are decreased to 10 megohms thus matching the impedance of the 100 and 1000 volt ranges.
INT LO - INT HI EXT-MAN and TRIGGER Control	The outer light-colored portion of this dual control is the INT-EXT-MAN four-position cycle command function switch. In the INT LO and INT HI positions the TDVM sampling rate is internally controlled and free runs at an average sampling rate of 2 cycles per second in the INT LO position and 200 cycles per second in the INT HI position. In the EXT position an external trigger source can be used to control the sample cycle. In the MAN position the sampling cycle is controlled by the inner dark portion of the dual control; the inner or TRIGGER section is a push-button switch which causes the TDVM to run through a single sampling cycle with each switch depression.
INT-EXT REF	Permits selection of an external reference source for the TDVM (EXT position), or normal use of TDVM reference source (INT position).
BAL-A, BAL-B	Amplifier balance controls. (See Paragraph 2b.)



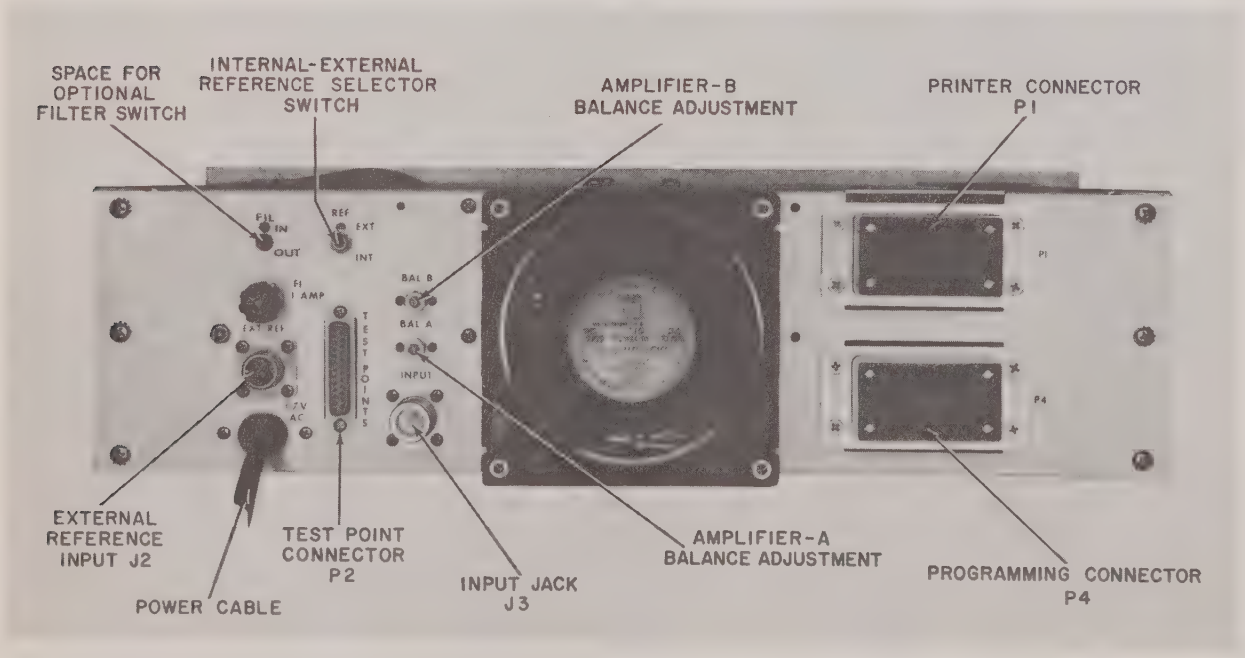


Figure 5. 5001 TDVM, Front and Rear Views Showing Controls and Connectors

CHAPTER IV

THEORY OF OPERATION

1. INTRODUCTION

This chapter describes the theory of operation of the TDVM in terms of a block diagram analysis, a functional diagram analysis, external control circuits, and a description of the reference and power supply circuits. These descriptions are supplemented by block diagrams, simplified schematics, a timing diagram, functional diagrams, logic diagrams, and a power distribution diagram. Transistor theory and standard circuits incorporating these devices are *not* described.

The 5001 TDVM utilizes the programmed-comparison type of meter circuit where the current produced by the unknown or input voltage is compared to a known reference current. The indicators display a voltage (in decimal equivalent) proportional to the magnitude of the reference that is required to null the unknown current.

2. BLOCK DIAGRAM ANALYSIS

Figure 6 is a simplified block diagram illustrating the operation of the 5001 TDVM. The unknown voltage is applied to the dual d-c amplifier and input circuits which provide proper scaling and isolation of the input. The scaling of the input permits the TDVM to handle the wide range of input voltages on the four range scales and maintain the required accuracy within each range. The dual d-c amplifier circuit permits selection of a positive representation of the input signal for application to the comparator amplifier summing junction regardless of the actual unknown polarity.

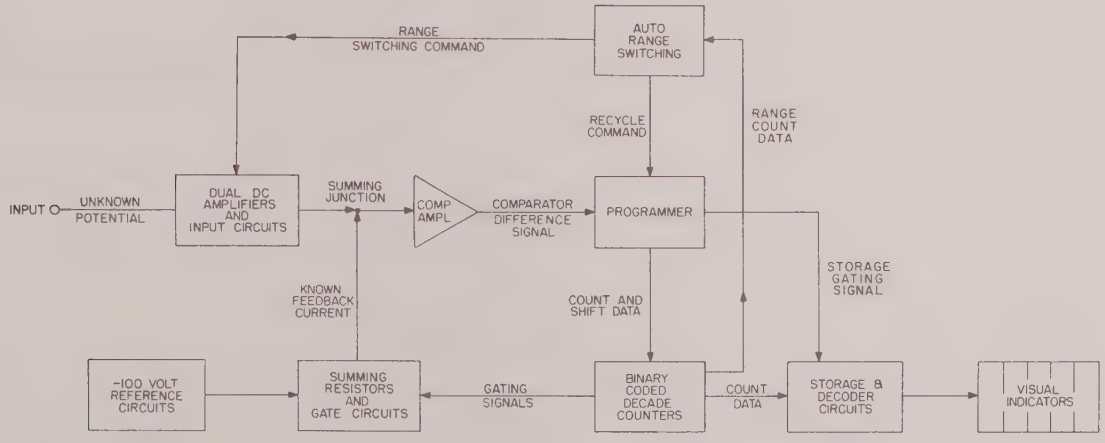


Figure 6. Simplified Block Diagram, 5001 TDVM

The positive polarity representation of the unknown is applied to the comparator amplifier summing junction where it is compared to a negative reference signal of known magnitude. The two signal currents (summed algebraically) form the input signal to the comparator amplifier. The comparator output (or difference signal) is determined by which of the two input signals at the summing junction is larger. This output does not indicate the *magnitude* of the difference but merely which is the *larger* of the two.

The comparator difference signal is sent to the programmer which in turn determines the counting instructions that are sent to the decade counters. The programmer data instructs the counters to increase or decrease the known feedback current to the summing junction based on the signal from the comparator amplifier.

In the automatic ranging mode the decade counter data is sampled by the auto range switching circuit. Dependent on the counter data the auto range circuit either permits the sampling cycle to continue (unit on proper range) or stops the cycle and up or down ranges the instrument as indicated by the count data. If range switching is required the auto range switching circuit also re-cycles the programmer so it re-starts at the beginning of the sampling cycle on the new range. In addition to its function of range switching in the automatic mode the auto range switching circuit also serves as an overload protection circuit for manual range selection. If the selected range is too low for the input voltage, the auto range switching circuit stops the sampling cycle and lights a red lamp in the extreme left-hand visual-indicator section. The instrument is momentarily switched out of the under-range setting thus protecting the precision input resistors. The instrument will return to the original range if the setting is not manually changed; however, the auto circuit instantaneously switches it out again if the overload still exists. This switching action will continue, and the red overload lamp will flicker until the unit is either up ranged (manually) to a proper setting or the over-voltage input is removed.

When the proper range is obtained the programmer is released to instruct the counters to increase or decrease the known feedback current as previously mentioned.

The counters indirectly control the feedback current by binary-coded-decimal voltage gating-signals applied to summing resistor gate circuits. The gating circuits in turn directly control the current flow from the -100 volt reference circuits to the summing junction in known binary-coded decimal steps. When the known reference current and the current due to the unknown are equal in magnitude the programmer stops the decade counter operation. The decade counters then contain, in binary-coded decimal form, the magnitude of the known current required to null the unknown current.

Storage gating instructions from the programmer (generated when the two currents are nulled) release previously stored data from the storage circuits and permit the insertion of the new binary-coded decimal count data. In addition these storage instructions hold the new data in the storage circuit thus permitting the release of the decade counters for a new sampling cycle of the input unknown.

The storage circuits apply the binary-coded data to decoder circuits which convert this data to numeric decimal notation. The numeric decimal data is applied to the indicators, illuminating the proper digits. The displayed digits are actually a scaled representation of the potential required to produce the known current, and because the known and unknown currents are equal in magnitude, it is a numeric representation of the unknown voltage *magnitude*. The indicators also display the polarity of the unknown (determined during the sign check cycle) and the decimal point location (determined by the range setting).

The entire sequence of events (polarity or sign check, magnitude evaluation and display) takes an average of 5 milliseconds when a range or polarity change is not involved. The actual time required to sample and display a given voltage may be calculated in the following manner. Assume that a clock pulse is generated by the blocking oscillator every 1/5 millisecond. It takes six of these clock-periods, regardless of the magnitude of the unknown voltage, to shift through the various counters (1000's through 1's) and to display the data. In addition it requires 1 clock-period for each digit of the magnitude from 1 to 9, plus the sign check time. As an example, if 12.48 volts (either positive or negative) is applied to the TDVM, in addition to the six required clock-periods 15 more clock-periods are required (1 clock-period for the 1 digit, 2 for the 2 digit, 4 for the 4 digit, and 8 for the 8 digit) or a total of 21 clock-periods. This total of 21 does not include that time required for the sign check; thus a total time of 4.2 milliseconds is required for the sampling cycle less the sign check time. If the signal polarity does not change, the sign check period is 1/5 millisecond and the entire operation takes 4.4 milliseconds. It takes about 15 milliseconds to operate the polarity relay (energize or de-energize); thus if there is a sign change (positive to negative input or vice versa) the operation takes about 4.2 + 15 or 19.2 milliseconds.

3. FUNCTIONAL DIAGRAM ANALYSIS

Schematic Diagram D026 158 0S, Sheet 1 through 3 (Appendix II) is a functional logic diagram of the 5001 TDVM and is used as the basis of this description. The sampling operation of the TDVM may be considered to take place in three steps: the sign check cycle, the magnitude evaluation cycle, and the storage and display cycle. The automatic range selection operation may be considered as part of the magnitude evaluation cycle. To simplify the description of the TDVM operation, however, the auto range switching circuit is described separately, as are the various special feature circuits such as the external or manual trigger circuit. This functional description is therefore divided into four separate sub-divisions. Three divisions, the sign check cycle, the magnitude evaluation cycle, and the storage and display cycle, are described assuming the instrument is in the proper range, that range switching is not required, and the instrument is set for internal triggering (free running). The fourth division describes the auto range switching circuit and its subsequent effect on the three operating steps of TDVM, should range switching be required.

For the following description assume the TDVM is properly ranged, has sampled, and is displaying a voltage value of +12.48 volts. Approximately 200 times a second the TDVM samples this applied voltage (average sampling time) thus keeping a constant check on actual voltage magnitude. After each of the sampling cycles the display is extinguished and the new sampled value displayed in its place. It takes about 1/5 millisecond to extinguish and replace the display; therefore, if the input does not vary, the display appears as if constantly illuminated.

Figure 7 is a timing diagram showing the voltage pulses at strategic points throughout the TDVM (portions of this diagram are exaggerated for clarity). The diagram is scaled across the top in intervals of time; each interval is equal to approximately 1/5 of a millisecond (0.0002 seconds). (This diagram is drawn in accordance with the assumption that range switching is not necessary.) The diagram starts at time t_0, the instant at which a new sampling cycle is started. The first step of the new sampling cycle is the sign check.

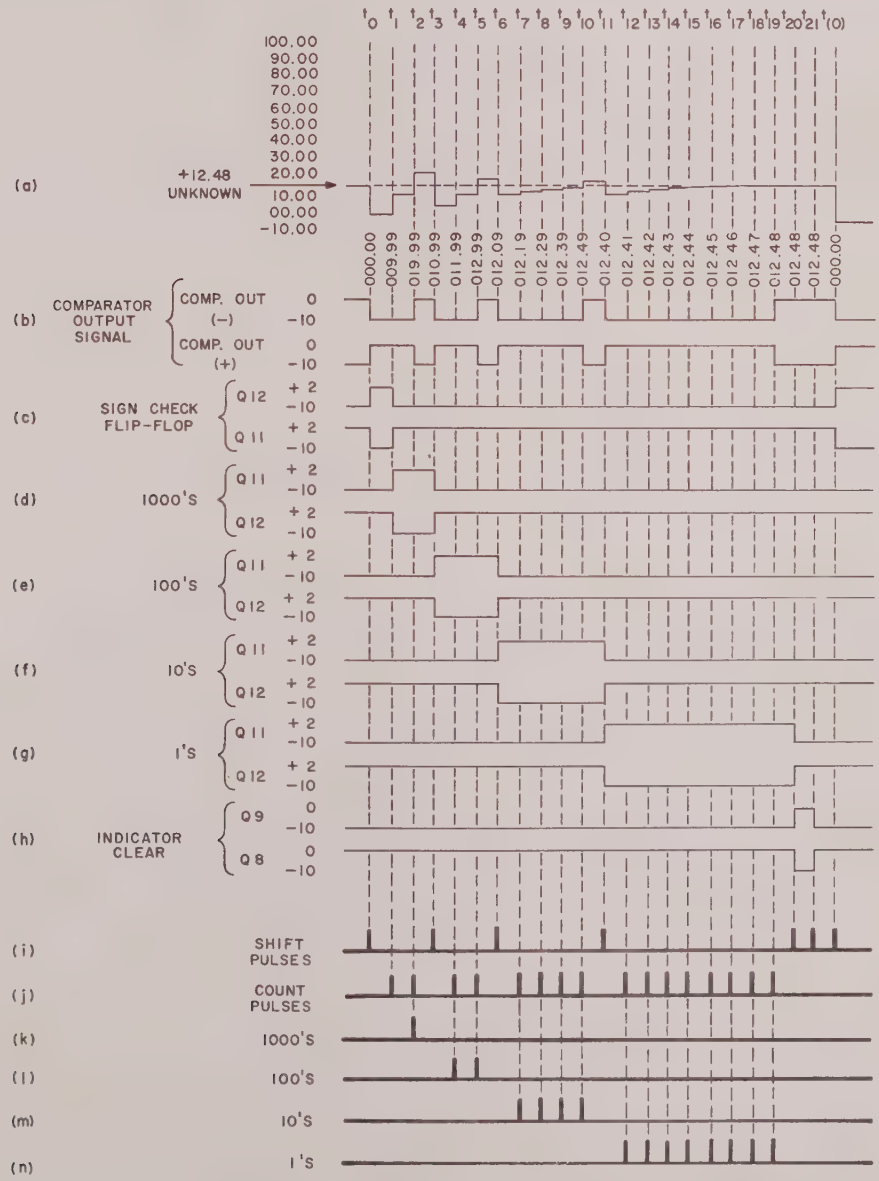


Figure 7. TDVM Timing Diagram

a. Sign Check Cycle

The TDVM is designed to function with a positive representation of the unknown input voltage applied to the comparator summing junction (regardless of the actual unknown polarity). The purpose of the sign check cycle is to assure that this condition is fulfilled before the actual sampling of the input unknown is attempted. In addition, the sign check cycle assures that the visual indicator displays the actual polarity of the unknown.

To assure the application of a positive polarity to the comparator, a relay (K1) is used at the output of the dual d-c amplifier (Figure 8). This relay permits the selection of the amplifier output from either the first section (b) or the second section (a) of the dual amplifier. If the input unknown is negative, taking the output from amplifier (b) provides the required positive representation for application to the comparator. If the unknown is positive, however, polarity relay K1 must be energized and the output of amplifier (a) used to provide the required positive representation.

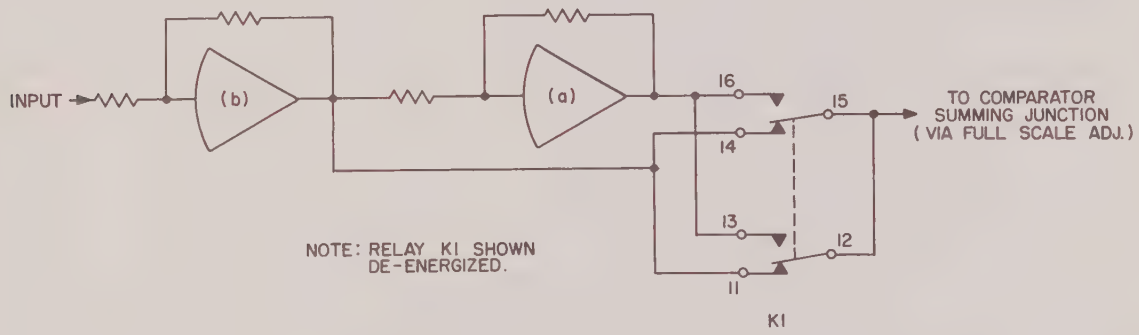


Figure 8. Dual D.C. Amplifier and Polarity Relay, Simplified Schematic

During the sign check cycle the TDVM must determine if the polarity relay, K1, is in the proper state; i.e., energized for positive unknown inputs and de-energized for negative potential unknown inputs. To determine if the relay is in the proper state the reference current is removed from the comparator summing junction so the summing junction is controlled by the unknown potential only. If the unknown representation is positive, K1 is in the proper state; if the unknown is negative, K1 must be reversed.

The sign check cycle starts at the time t_0 as shown on the timing diagram, Figure 7. At time t_0 the TDVM has completed its previous sampling operation and the unit is set to start a new sampling cycle. This new sampling operation is started (at t_0) when a clock pulse from the blocking oscillator triggers the sign check multivibrator (Q11 and Q12, Figure 9 and curve c, Figure 7). Q11 is cut off and generates a negative voltage which is routed out pin J of the programmer card to the zero-set transistor (Q10) on each of the four binary-coded decade counter (BCD) cards (D026 158 0S, Sheets 2 and 3). Q10 on each of the BCD cards sets the circuit to a zero count. Since the BCD cards control the reference current applied to the comparator summing junction (via diode gating), zero-setting the cards removes all reference current from the comparator summing junction. At time t_0, therefore, the comparator summing junction is controlled by the unknown voltage representation from the output of the dual d-c amplifier.

The comparator amplifier is a five stage transistor amplifier with outputs taken from the fourth and fifth stages (Q4 and Q5 respectively). The output at Q4 is designated *Comp Out* + and from Q5, *Comp Out* - (D026 158 0S, Sheet 1). The operation of the comparator is such that if the input is positive Q4 is saturated (collector at zero), and Q5 cut off (collector at -10 volts). A negative input reverses the situation, i.e., Q4 cut off, Q5 saturated. Thus, the *Comp Out* + lead essentially indicates the polarity of the signal applied to the comparator as follows: if the comparator input is positive the *Comp Out* + lead is at zero, if the comparator input is negative the *Comp Out* + lead is at -10 volts. The voltage on the *Comp Out* + lead between time t_0 and t_1 is used to indicate to the programmer whether or not relay K1 is in the proper state. The *Comp Out* + potential is applied to an AND circuit in the programmer (CR3 and R17) along with the negative pulse from Q11 of the sign check multivibrator (Figure 9).

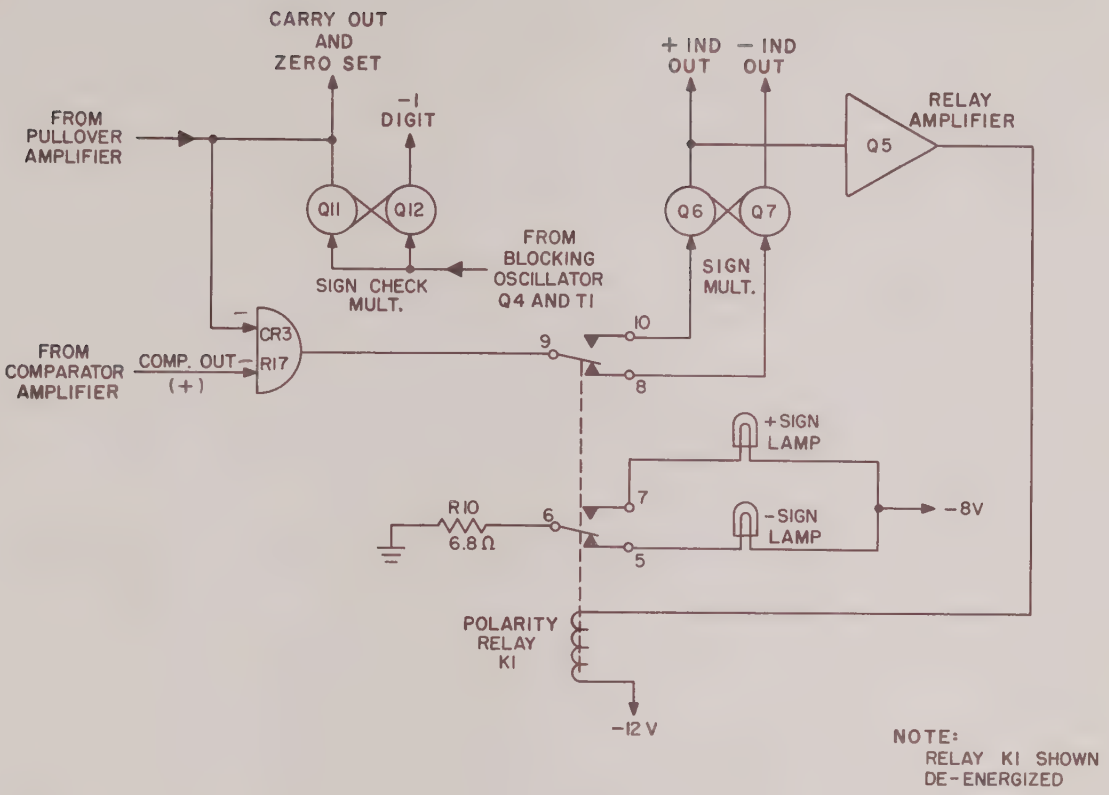


Figure 9. Sign Check Circuit, Simplified Logic Diagram

Both inputs to the AND circuit must be negative to produce an output. Since the input from the sign check multivibrator (Q11) is always negative during the sign check cycle the operation of the AND gate is controlled by the *Comp Out* + lead which is only negative when the polarity relay is in the *improper* state. Thus, during the sign check cycle, if a negative potential is applied to the comparator summing junction a pulse is passed through the CR3-R17 AND gate in the TDVM programmer. If a positive input is applied to the summing junction during this period, however, (*Comp Out* + lead at 0) no pulse will pass through the AND gate.

If a pulse passes through the AND gate it is applied to either Q6 or Q7 of the sign multivibrator depending on the state of K1. As shown in Figure 9, with K1 de-energized, the pulse is applied to Q7 triggering it into conduction. This action cuts off Q6, its collector drops to -10 volts and Q5 conducts energizing the relay. Contact K1-9 then closes with K1-10. Note that K1-9 is always connected to the side of the sign multivibrator which is cut off, i.e. K1-9 contacts K1-8 when Q7 is cut off (Q6 conducts and K1 is de-energized), K1-9 contacts K1-10 when Q6 is cut off (K1 is energized). Therefore, any time a pulse is passed through the AND gate (indicating K1 is in the wrong state) the sign multivibrator is triggered to the opposite state reversing the condition of K1.

Contacts K1-5, 6, and 7 control the polarity indicator lamps in the visual display unit. When K1 is de-energized the negative lamp lights; when K1 is energized the positive lamp lights.

The output of Q12 of the sign check multivibrator during the sign check cycle is applied to the summing junction of the comparator. This low-level signal will only effect the circuitry on a zero or an extremely low-level input signal when it functions to prevent polarity-relay chattering.

As previously stated, in this description it is assumed the instrument has sampled and displayed +12.48 volts and that the sampling operation being described assumes the +12.48 volts is still applied to the instrument. Under these conditions K1 is energized and at time t_0 the proper positive representation of the unknown is applied to the

comparator summing junction. No pulse can pass through the AND gate (Comp Out + lead at 0) and the relay remains in the energized state. When a change of the relay condition is not required the sign check cycle takes approximately 1/5 millisecond to complete. A change in the relay state, however, (polarity reversal at the input), requires a minimum of 10 milliseconds. The purpose of this minimum delay is described in sub-Paragraph *d*.

At time t_1 (Figure 7) the sign check cycle is stopped (assuming K1 is not reversed) when the next blocking oscillator pulse triggers the sign check multivibrator back to its original state (Q11 conducts, Q12 cut off). At time t_1, therefore, the TDVM starts the second phase of operation, the magnitude evaluation cycle.

b. Magnitude Evaluation

Up to this point the TDVM has checked the polarity of the unknown and assured that a scaled positive representation of this potential is applied to the comparator. In addition the unit registers the polarity of the unknown on the visual readout indicators. During the magnitude evaluation phase of the sampling operation the TDVM brings the known reference current level applied to the comparator summing junction into agreement with the current due to the unknown potential.

Figure 10 illustrates how a typical BCD card controls the known reference current flow to the comparator summing junction. When a BCD registers a binary-coded 0, all of the counter multivibrators (designated 1, 2, 4, and 8 on Figure 10) are set in the *1* state, i.e., Q2, Q4, Q6, and Q8 conducting. These transistors apply a positive potential to the anodes of the diodes designated a, b, c, and d which in turn back-biases a', b', c', and d' respectively. Thus current flow through resistors 1, 2, 4, and 8 cannot pass through the back-biased diodes to the comparator summing junction. If, however, any of the counters are set in the *0* state (odd transistor conducting) the corresponding diode of the *0* state counter (a, b, c, or d) is back-biased. This removes the back-bias from the corresponding primed diode and permits current to flow from the -100 volt source, through the associated resistor, to the summing junction.

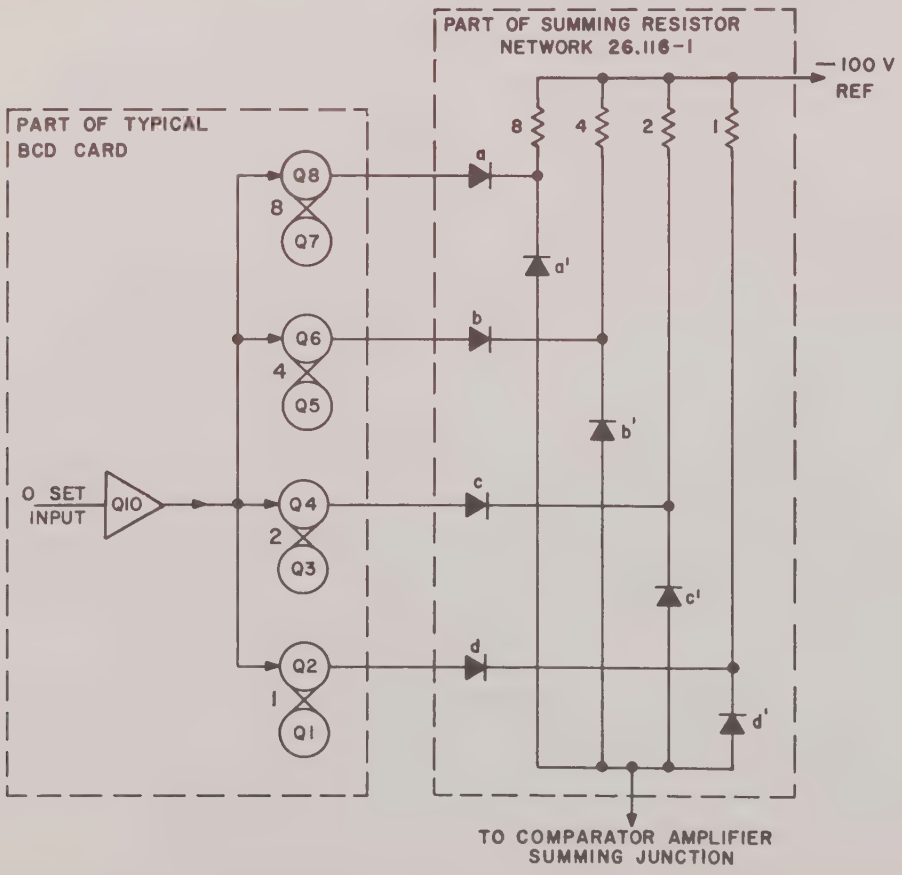


Figure 10. Typical BCD and Diode Gate Circuit, Simplified Logic Diagram

The resistors are matched such that the current flow relationship with respect to each other is in binary-coded decimal steps. Each BCD controls a set of four resistors and these sets are matched with respect to each other on decimal relationship such that the units BCD set is 10 times that of the tens set, 100 times that of the hundreds set and 1000 times that of the thousands set. This permits the counters to control the reference current flow to the comparator amplifier summing junction in four decimal groups of binary-coded decimal steps of known magnitude. When the known current is in agreement with the unknown (in magnitude), the magnitude of the unknown is recorded in the BCD count.

Figure 10 also shows the 0-set transistor Q10; at time t_0 when Q11 of the sign check multivibrator triggers this circuit the BCD card is set to a zero count. Each BCD contains a 0-set circuit; thus, at time t_0 all reference current is removed from the comparator summing junction.

At time t_1 the magnitude evaluation starts when the sign check multivibrator reverses its state (due to a pulse from the blocking oscillator). The collector of Q11 (of the sign check multivibrator) goes slightly positive; this positive potential reverses the state of the 1000's multivibrator (Q11 and Q12) on the 1000's binary-coded decimal counter. (D026 158 0S, Sheet 3.)

In reversing the state of the 1000's multivibrator (Figure 7) a positive potential is applied to the anode of diode CR21 (Figure 11). This biases CR21 so the count pulses (added to this bias voltage) are sufficient to trigger the 1's counter multivibrator (Q1 and Q2). If Q11 is cut off and a negative potential is applied to the anode of CR21 the count pulses at this time are not of sufficient magnitude to trigger the counters.

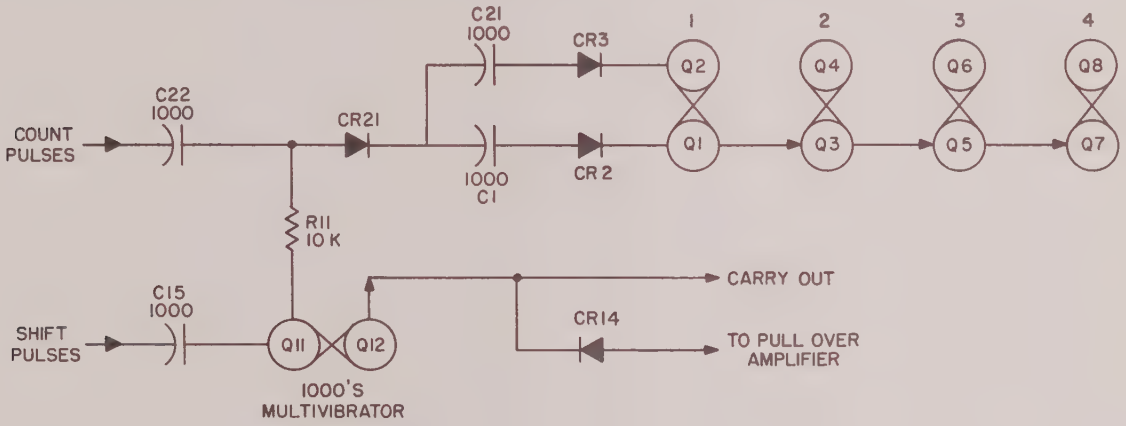


Figure 11. Typical BCD Count and Release Circuit, Simplified Logic Diagram

At time t_1 only Q11 of the 1000's multivibrator is set to the proper state; thus, only the 1000's decade counter can react to the count pulses. The negative pulse generated by Q12 at this time is applied to the 9-set transistors (Q9) of the 100's, 10's, and 1's counter (D026 158 0S, Sheet 3). The 100's, 10's, and 1's decade counter cards are each set to a nine count (Q2 and Q8 cut off) permitting current representing a 999 count to flow to the summing junction from the reference source. This is equivalent to applying current from a -9.99 volt source to the summing junction when the meter is on the 100 volt range (as is necessary to measure +12.48 volts).

In addition to 9-setting the remaining counters, the negative potential from the collector of Q12 (of the 1000's multivibrator) is applied through diode CR14 to the base of the pullover inverter (Q10) on the programmer card. The pullover inverter *locks the sign check multivibrator* (Q11 conducting, Q12 cut off) *preventing it from being triggered during the evaluation cycle.*

At time t_1 to t_2 current at the summing junction of the comparator amplifier is controlled by two voltage sources: the scaled positive representation of the unknown input (+12.48 volts) and the scaled equivalent of -9.99 volts from the negative reference source. Between times t_1 and t_2, therefore, the positive unknown potential, being larger, controls the comparator summing junction current, and Q1 of the comparator is cut off. This causes the *Comp Out* + line to be at ground potential and the *Comp Out* - line to be at -10 volts.

The *Comp Out* + and *Comp Out* - leads are connected to Q1 and Q2 of a double AND gate (D026 158 0S, Sheet 2). Pulses from the blocking oscillator are continually applied to both of these transistors via emitter follower Q3. Q3 functions to isolate the blocking oscillator to prevent loading that circuit.

Either Q1 or Q2 passes the blocking oscillator pulses if the corresponding *Comp Out* lead connected to that transistor is negative. At time t_2 the *Comp Out* - lead is negative; thus Q2 passes the blocking oscillator pulse. The output of Q2 forms the count pulses and these are sent to all of the binary-coded decade counters. The 1000's counter is the only unit released for counting at time t_2; therefore, it registers a *1* count. This increases the known current flow to the summing junction to a value equivalent to -19.99 volts. At time t_2 then, the known current becomes larger than the unknown (+12.48 volts). The comparator summing junction comes under the control of the negative current source and the Comp Out + line goes to -10 volts. *

The -10 volts on the *Comp Out* + lead permits the blocking oscillator pulse at time t_3 to pass through Q1 of the double AND circuit. This is the TDVM *shift* pulse. The *shift* pulse (a positive pulse) is applied to Q11 of the 1000's, 100's, 10's, and 1's multivibrators (D026 158 0S, Sheet 3 and Figure 11). Q11 of each multivibrator is cut off in each case, with the exception of the 1000's multivibrators. The *shift* pulse only effects the 1000's multivibrator and triggers this circuit to its opposite state (Q11 cut off, Q12 conducting). As Q12 conducts, the collector voltage goes in a positive direction; the positive voltage is applied to Q12 of the 100's multivibrator triggering this circuit to its opposite state.

Triggering the 100's multivibrator releases the 100's counter for counting. In addition the negative-going voltage of Q12 of the 100's multivibrator (curve *e* of Figure 7) is applied to the 100's zero-set transistor (Q10) setting the 100's counter to zero. This changes the apparent negative potential applied to the comparator summing junction from -19.99 volts to -10.99 volts. The current due to the +12.48 volt representation of the unknown regains control of the summing junction. The *Comp Out* - lead becomes -10 volts and the next blocking oscillator pulse generates a *count* pulse.

The negative potential from the collector of Q12 (100's multivibrator) is applied to the base of the pullover inverter. Thus, even though Q12 of the 1000's counter is conducting, the negative potential from Q12 of the 100's counter prevents the sign check multivibrator from being triggered.

At time t_4 the blocking oscillator pulse is passed through Q2 of the double AND circuit and sets the 100's counter to one. The known current at the summing junction becomes equivalent to -11.99 volts. The unknown voltage representation (+12.48 volts) is still larger however; thus at time t_5 a second count pulse is generated. The 100's counter is set to a two-count (curve 1, Figure 7) and the negative or known voltage equivalent becomes -12.99 volts. With the known current controlling the summing junction a shift pulse is generated at time t_6. The shift pulse sets the 10's counter for counting and locks the 100's counter.

The counting process continues in a similar manner as until time t_{19} when the known and unknown current are in agreement (in magnitude). At this time the summing junction goes under control of the negative potential of the zero set potentiometer R2. The *Comp Out* + lead is therefore at -10 volts at time t_{20} and a shift pulse is sent from the programmer. This shift pulse reverses the state of the 1's multivibrator, stopping the counting cycle and starting the conversion and display cycle.

c. Conversion and Display Cycle

Up to time t_{20} the TDVM has checked the polarity of the unknown, illuminated the proper visual readout sign indicator and brought the reference feedback current magnitude into agreement with the unknown current magnitude. Since the magnitude of the reference current is controlled by the BCD cards, the BCD count must also be an indication of the unknown input magnitude. During the conversion and display cycle the BCD count is transferred to the readout storage decade (RSD) cards for storage and conversion to arabic decimal for display on the visual readout. Storage of the BCD count in the RSD cards permits clearing (or zero-setting) the BCD card so a new sampling operation can be made while the previously attained value is held and displayed.

As previously stated the conversion and display cycle starts at t_{20} when a shift pulse from the programmer reverses the state of the 1's multivibrator (curve *g*. Figure 7). The positive collector voltage of Q12 of the 1's multivibrator is applied to Q8 of the indicator clear multivibrator on the programmer card cutting it off and applying its negative collector potential to the pullover inverter, maintaining it in the conducting state; thus the sign check multivibrator is held in the locked condition.

**Although the Comp Out + lead is at -10 volts this does not affect the sign multivibrator because the sign check multivibrator is locked by the pullover inverter.*

The positive collector voltage of Q9 of the indicator clear multivibrator is the actual clearing signal. This signal is applied to the indicator clear gate Q3 (on the Network Card, C012 1064 0S) cutting it off (Figure 12). Transistor Q3 in its normally conducting state forward-biases the gating diodes on the RSD cards (CR5, 13, 14, 21, 22, 29, 30, and 36 on Figure 12 and Schematic Diagram D051 010 0S). *

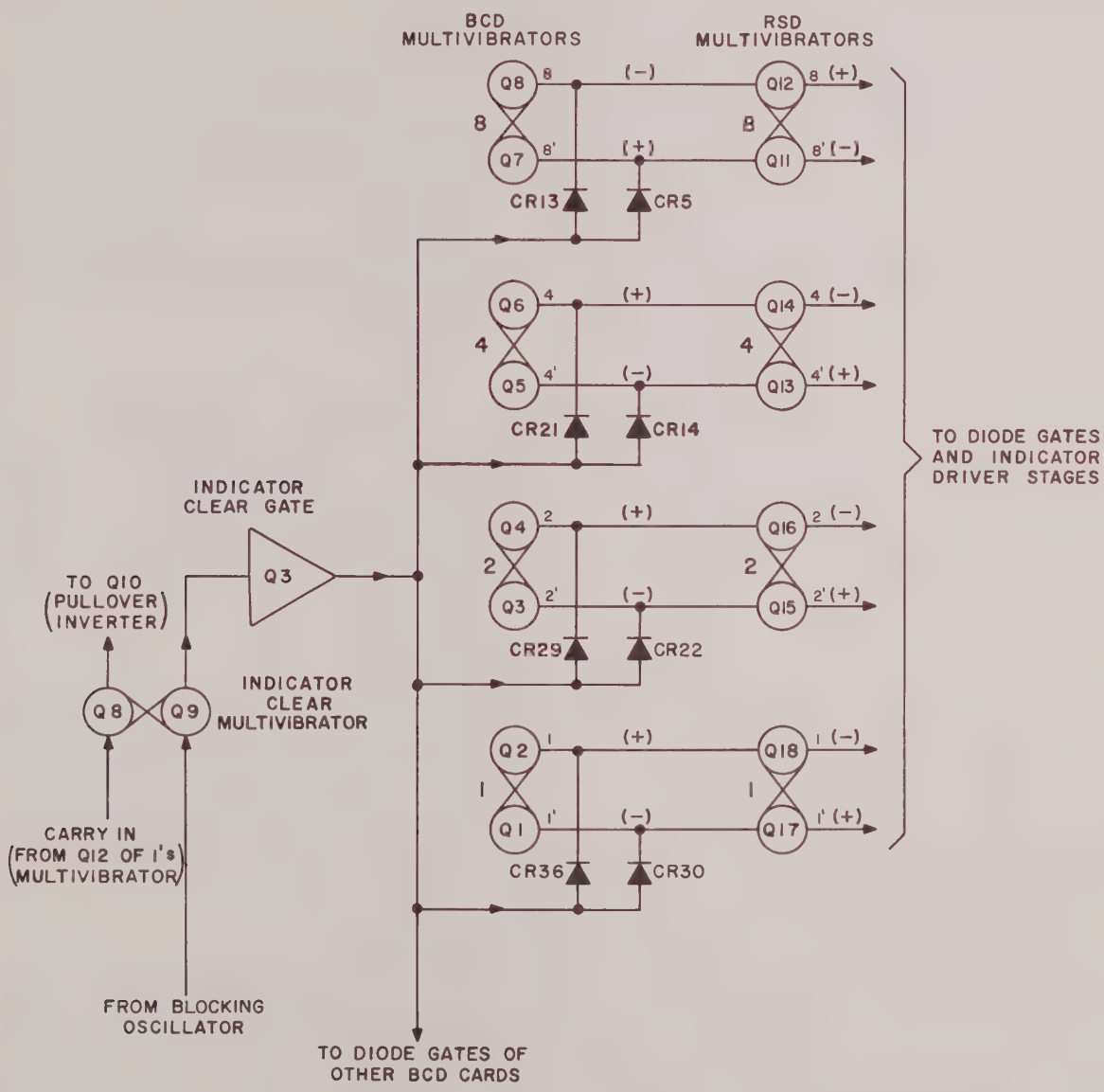


Figure 12. Typical Indicator-Clear Gating Circuit, Simplified Logic Diagram

Due to the similarity of operation between the 51.080-5 and 51.010 Models of the RSD card only the operation of the 51.010 is used in this description.

The forward biased diodes prevent the operation of the BCD cards from affecting the RSD multivibrators during the sampling operation. At time t_{20} when Q3 is cut off (reverse biasing the diode) the state of the BCD counters triggers the corresponding RSD multivibrators in a similar but opposite state. As an example, Figure 12 shows the collector voltages of the BCD and RSD multivibrators in parenthetical notations (where + = 0 volts and - = -10 volts) for a binary-coded eight. Note that the collectors of the RSD multivibrators are opposite to those of the BCD counters.

At time t_{21} the blocking oscillator triggers the indicator clear multivibrator back to its original state (Q8 conducting, Q9 cut off). This permits the indicator clear gate Q3 to conduct and locks the RSD multivibrators with the new count so subsequent action of the BCD counters can not effect them. At the same time the pullover inverter is released; thus, at time t_{22}, shown as $t_{(0)}$ on Figure 7, the sign check indicator is released so the blocking oscillator pulse can zero-set the counters and the TDVM can start a new sampling operation.

Figure 13 is a logic diagram illustrating the conversions of the binary-coded decimal data to arabic decimal. Following through with the binary 8 used in Figure 12 the plus and minus parenthetical notations in Figure 13 indicate 0 and -10 volts respectively.

The AND gates shown in Figure 13 correspond to the diodes of Schematic Diagram D051 010 0S. Note on the schematic that the base of each of the drivers (Q1 through Q10) is connected to the -8 volt supply and will conduct *unless* one or more of the diodes is forward biased. Thus for a driver to conduct and illuminate its corresponding digit lamp each diode of its base AND circuit must be reverse biased; i.e., for the 8 digit to light (Q9 conducting) the 8' and 1 inputs to the Q9 AND circuit of Figure 13 *must both be negative* and at least *one* of the inputs to all the other AND circuits must be *positive*. Studying the parenthetical notations of Figure 13 shows that this is true. (Note that because of the previously mentioned reversal of collector potentials between the BCD counters and the RSD multivibrators that the 1, 2, 4, and 8 outputs are used instead of the 1', 2', 4', and 8' to indicate a zero, and similarly 8' and 1 indicate an 8.)

Figure 14 is a simplified logic diagram for the 51.080-5 RSD card. This card is essentially a modification of the 51.010 Card; the modification permits the card to store and read out the additional 10,000's count necessitated by the 20 percent overrange capabilities of the instrument. Note the similarity in logic between Figures 13 and 14; differences in logic are directly related to the overrange capability. As an example, the 9-driver AND circuit of the 51.080-5 RSD uses the *2* intelligence in addition to the 8' and 1' as used by the 9-driver AND circuit of the 51.010 RSD. The additional *2* prevents the 51.080-5 9-Driver from conducting when an eleven count is registered. The 0 and 1-driver inputs are extensively modified on the 51.080-5 RSD due to the necessity of Q11 being required to conduct on both a 0 and 10 count and the Q12 requirement for both a 1 and 11 count.

In the case of an increasing gradient voltage where the ramp is extremely steep, or a voltage in which there is a sudden rise in magnitude, it is possible for the voltage to rise above the sampling point before the magnitude evaluation is complete. As an example, assume that the meter starts a sampling cycle when the unknown is equal to 12.00 volts in magnitude. Assume that a sudden rise in potential places the input magnitude at 13.00 volts at the instant that the 10's counter starts its count cycle. This means that at the instant the unknown is at 13 volts a reference current equal to 12.09 volts appears at the summing junction. The 1000's and 100's counters are locked and cannot increase their count; thus, even if the 10's counter counts to its maximum (9 count), the reference current (equal to 12.99 volts) is not sufficient to control the comparator summing junction and cause a shift pulse; thus the counters would stop cycling. To prevent this situation, two diodes (CR17 and CR18 in the 44.139 Units) are connected in parallel between the 1 and 8-count output leads of the BCD flip-flops and the base of Q12 of the corresponding 100's, 10's, or 1's multivibrator. Thus as a counter reaches 9, it automatically shifts to the next counter due to a positive pulse through CR17 and CR18, and the sampling cycle is completed. A similar circuit is provided in the 1000's BCD (44.139-4 Unit) except the automatic shift (provided by CR17 and CR201) takes place on a 12 count. (It should be noted that the digital information obtained at the end of a sampling cycle will always represent the magnitude of the signal voltage at some point during the cycle, even though the input was changing rapidly.)

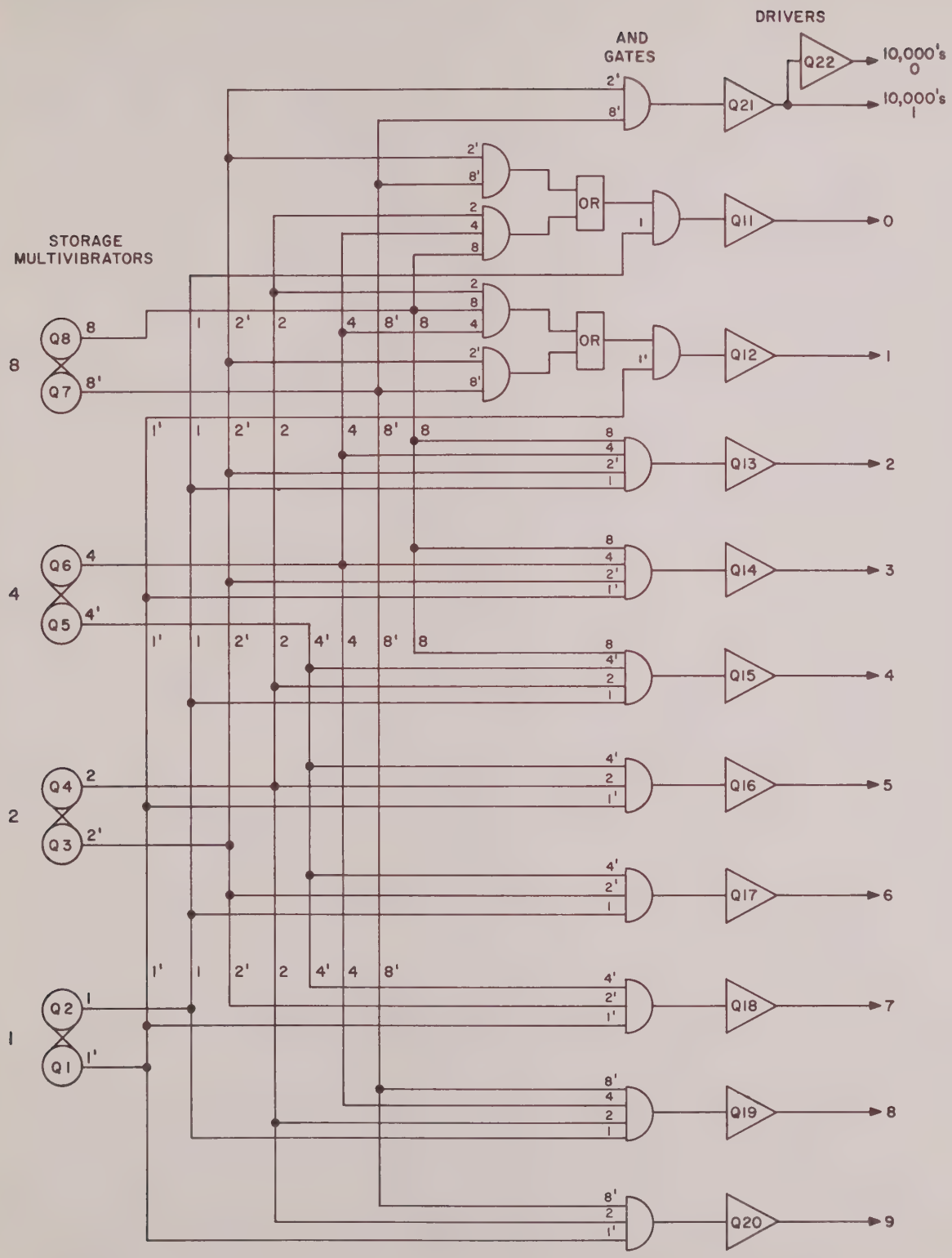


Figure 14. RSD 51.080-5 Binary-to-Decimal Decoding, Simplified Logic Diagram

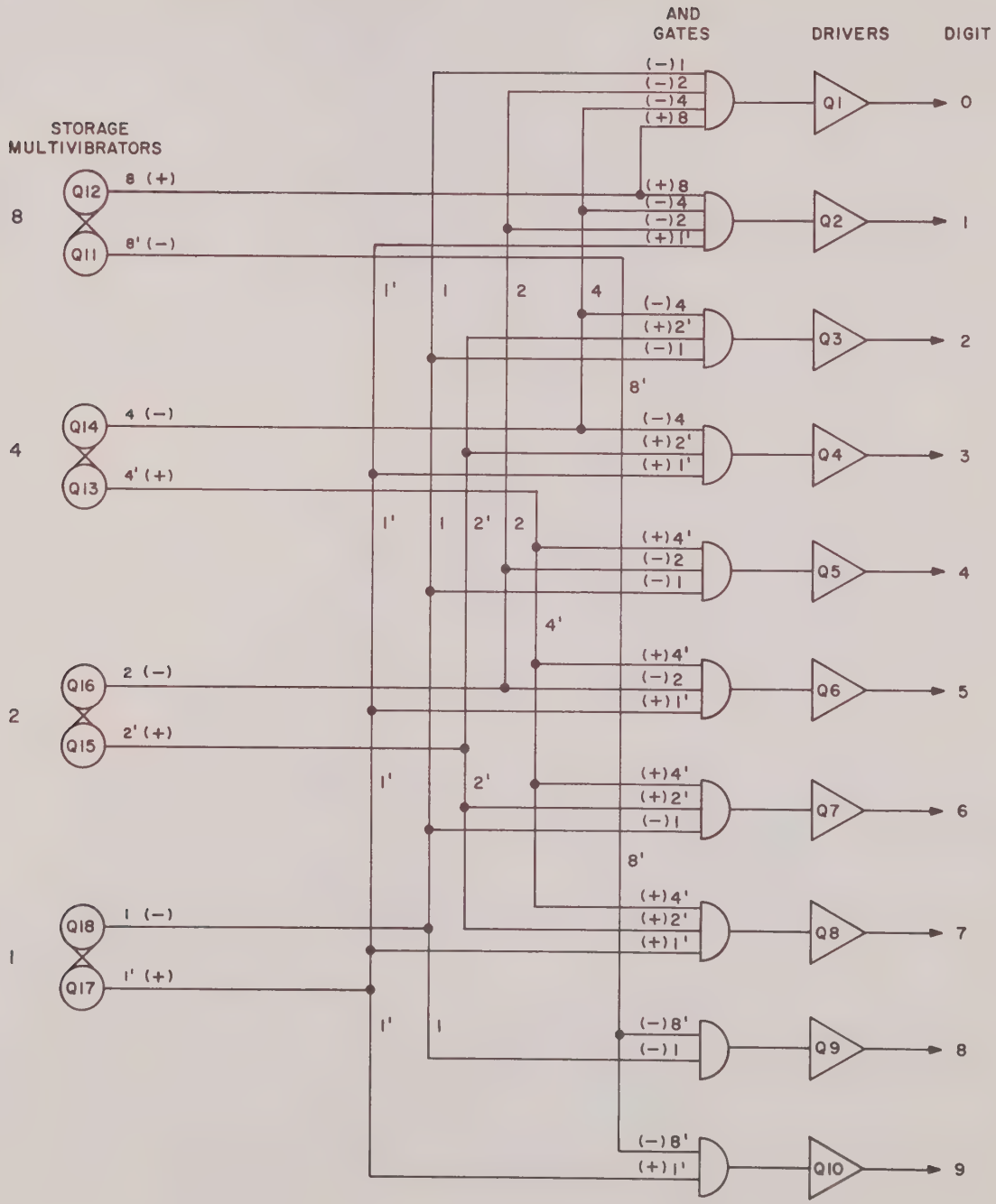


Figure 13. Typical 51.010 RSD Binary-to-Decimal Decoding, Simplified Logic Diagram

The following table briefly summerizes the TDVM operation as described in detail in the preceding paragraphs. The summary is given with respect to the time increments of Figure 7. (This table, as in the preceding text, assumes a +12.48 volt input.)

TIME	OPERATION
0	Sign Check Multivibrator triggered; sets decade counters to zero and checks relay K1 to ascertain that it is in the proper state. (In addition a small positive potential is applied to the comparator summing junction to prevent possible relay chatter on low-level input signals.)
1	Sign Check Multivibrator state reversed: 1000's multivibrator triggered, releasing 1000's counter; 100's, 10's, and 1's counters 9-set. Reference current proportional to -09.99 volts applied to summing junction.
2	Reference current *smaller* than unknown: 1000's counter counts to one. Reference current now proportional to -19.99 volts.
3	Reference current *larger* than unknown: shift pulse reverses 1000's multivibrator (locking 1000's counter) which in turn triggers 100's multivibrator. 100's multivibrator in operating zero-sets 100's counter. Reference current now proportional to -10.99 volts.
4 through 19	During this time period the counting cycle continues through the 100's, 10's, and 1's counters until the reference current is proportional to -12.48 volts (equal in magnitude to the input unknown).
20	Reference and unknown *equal* in magnitude: shift pulse clamps units multivibrator which in turn triggers indicator clear multivibrator. Decade counter data transferred to storage cards for conversion and display.
21	Indicator clear multivibrator reversed: data clamped in storage circuits; pullover inverter cut off thus releasing sign check multivibrator. The next blocking oscillator pulse triggers sign check multivibrator and starts new sampling cycle.
22 (0)	Sign Check Multivibrator triggered; new sample operation started.

d. Automatic Range Selection

The automatic range switching circuit performs two separate functions depending on the operating mode of the TDVM (automatic or manual range selection). In the automatic range selection mode (selected either locally or remotely) the circuit seeks and selects the lowest possible range capable of measuring a given input voltage (up to 20 per cent overload of a range). When a range is selected manually the circuit acts as an overload protection circuit to prevent damage of the precision input circuitry.

This description assumes the instrument is in the automatic range selection mode; however, a description of circuit action when the instrument is in either the manual or remote modes is also given. The Automatic Range Switching Circuit 14.156-1 (Schematic D014 156 0S) essentially consists of two parts (down range and up range circuits); for clarity, these circuits are described separately.

Figure 15 is a simplified logic diagram of the down-range portion of the 14.156-1 Unit (portions of this circuit are common to the up-range circuit). The state of relays K2 and K3 determines the gain of the input dual d-c amplifier circuit and thus the range of the TDVM. Figure 16a is a simplified schematic of the dual d-c amplifier circuit showing relays K2 and K3. Figures 16b through e are simplified schematics showing the feedback circuit of the d-c amplifiers in each of the four ranges as a resultant of the operation of the two relays.

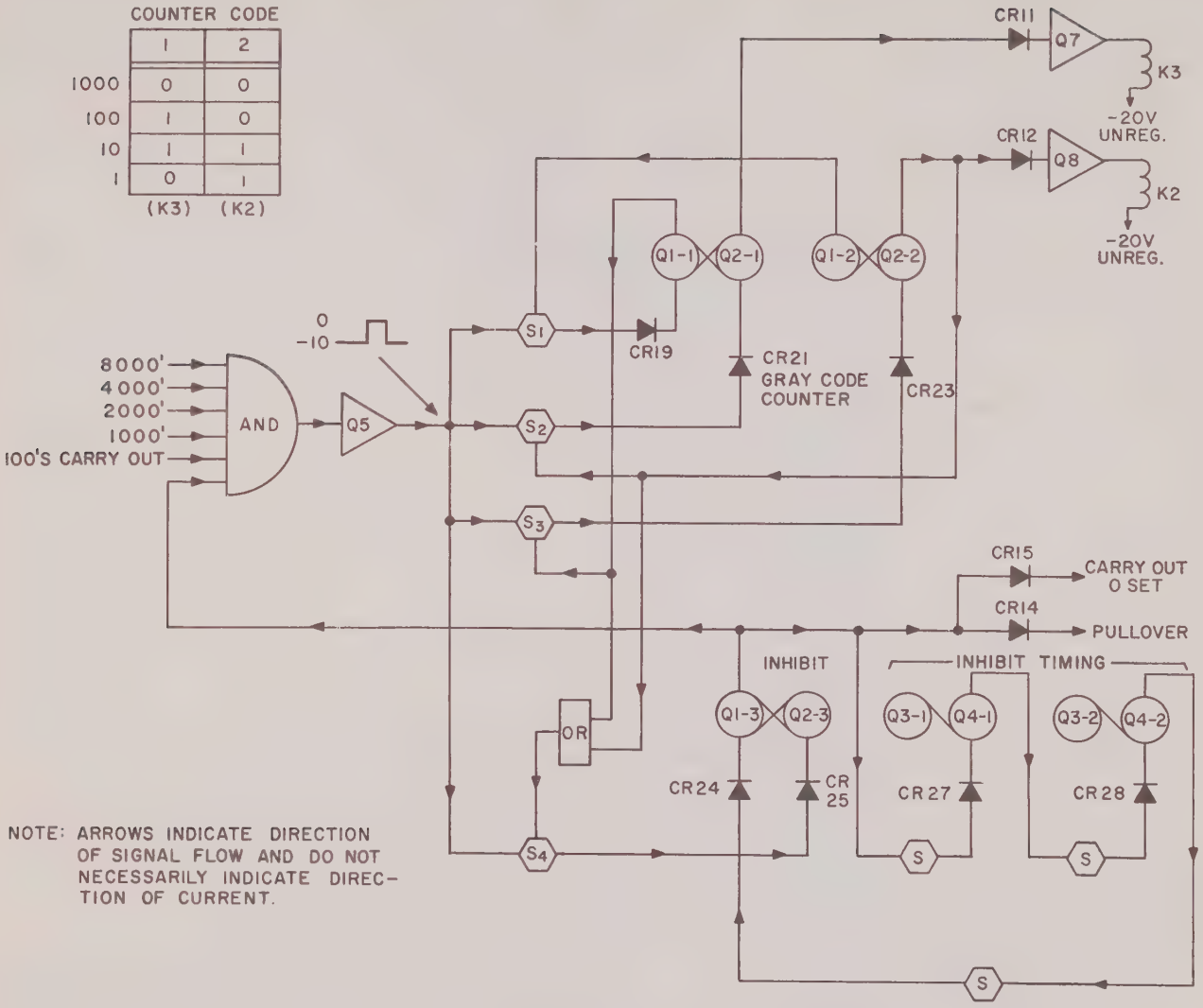


Figure 15. Down Range Circuit, Simplified Logic Diagram

Relays K2 and K3 (Figure 15) function in response to the gray-code counters consisting of multivibrator-1 (Q1-1 and Q2-1) and multivibrator-2 (Q1-2 and Q2-2). Multivibrator-1 controls relay K3 and multivibrator-2 controls relay K2; when either of the multivibrators is in the 1 state (right-hand transistor cut-off, left-hand transistor conducting) its corresponding relay is energized. The table in Figure 15 lists the state of each multivibrator on the four ranges of the TDVM; the parenthetical notation under each column designates the relay controlled by that portion of the counter. To change ranges, therefore, it is necessary to change the status of the counter circuit. Note, however, that the TDVM will only down range one step at a time, i.e., if the proper scale is the 1 volt range and the instrument is on the 100 volt range, it will first step to the 10 volt range and then the 1 volt range.

The AND circuit on Figure 15 indicates if down ranging is required by sampling the output of the 1000's BCD counters and the 100's carry out voltage. If the 1', 2', 4' and 8' outputs are all negative this indicates a zero in the 1000's BCD. This information alone, however, is not sufficient since this condition also exists during the sign check cycle. Therefore an additional bit, the 100's carry out, indicates to the AND circuit that not only is the 1000's count zero but that the 100's counter has been released for counting and the 1000's zero is a result of magnitude evaluation, and not sign check. The zero in the 1000's counter at his time indicates the TDVM is on too high a range. The final input indicates to the AND circuit whether or not the TDVM is already in a range change cycle; this circuit is described later in the text.

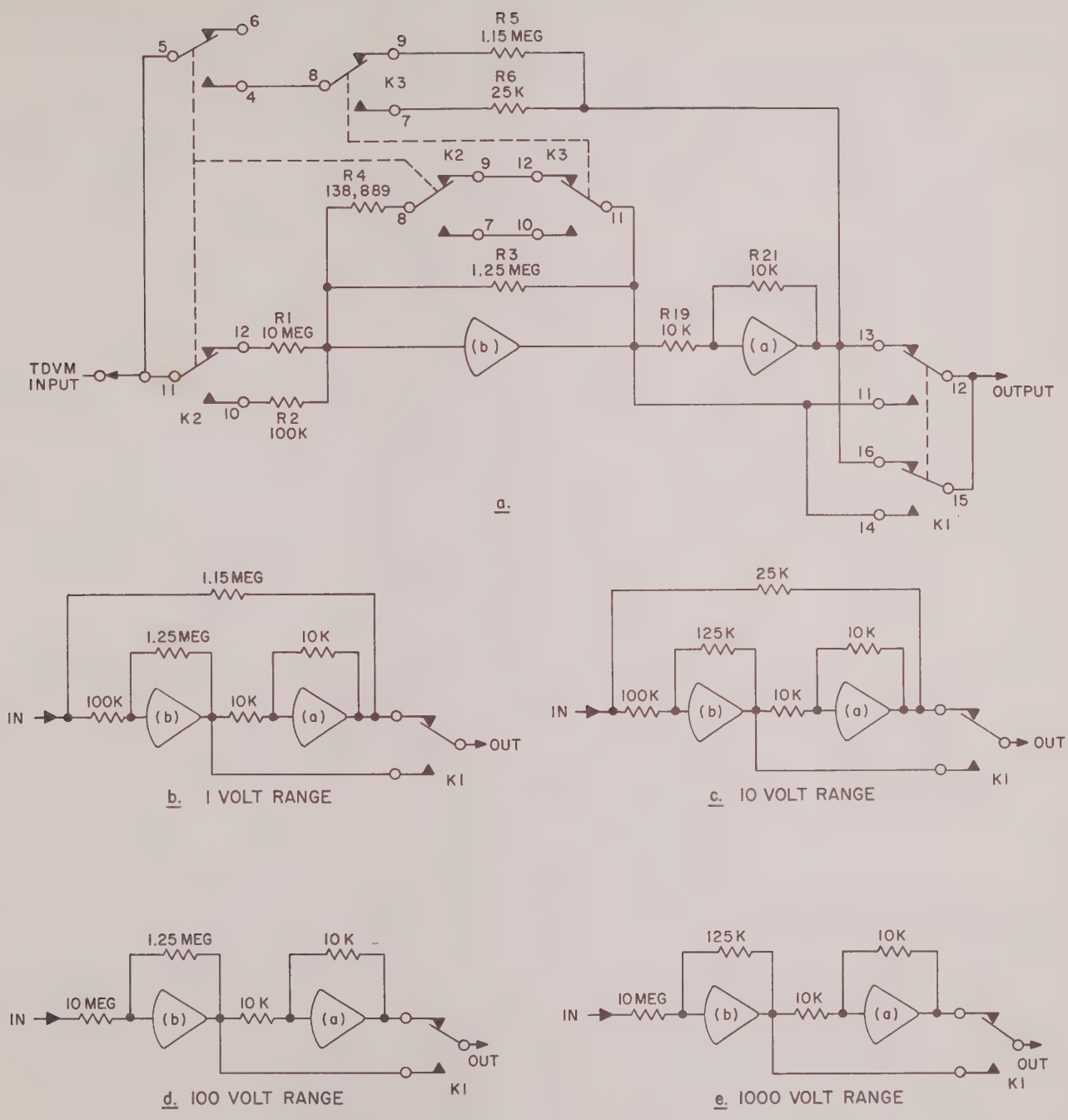


Figure 16. Dual D.C. Amplifier, Simplified Schematic Diagrams

Assuming that the 1000's counter is at zero, the 100's counter is open for counting, and the TDVM is not in the process of down ranging, the AND circuit (because of all negative inputs) saturates amplifier Q5. This generates a positive potential that is applied to the gated differentiators S_1 through S_4. The pulse from Q5 contains only the intelligence that the TDVM must be down-ranged; thus, by gating the differentiators as to which range the TDVM is on, the pulse is guided through the proper differentiators to down-range the TDVM to the next lowest range.

Table V lists by range the state of the collectors of each transistor in the counter, and the differentiators that are released.

TABLE V. Differentiator Gating Sequence

RANGE	GRAY CODE		MULTIVIBRATOR-1		MULTIVIBRATOR-2		RELEASED DIFFERENTIATOR
	MULT-1	MULT-2	Q1-1	Q2-1	Q1-2	Q2-2	
1000	0	0	-10	+2	-10	+2	S_2 & S_4
100	1	0	+2	-10	-10	+2	S_3 & S_4 (S_2)
10	1	1	+2	-10	+2	-10	S_1 & S_4 (S_3)
1	0	1	-10	+2	+2	-10	(S_1)

Comparing the table with Figure 15 the function of each gated differentiator may be derived as follows: a pulse through S_1 sets multivibrator-1 in the 0 state; a pulse through S_2 sets multivibrator-1 in the 1 state; a pulse through S_3 sets multivibrator-2 in the 1 state; and a pulse through S_4 triggers the inhibit multivibrator.

Under the released-differentiator column of the table (in the 100, 10, and 1 volt ranges) are differentiator designations in parentheses; these differentiators although released, do not function in the actual down-range operation. In being released however, they do prevent possible false triggering of one multivibrator (via transient pulses) when the other multivibrator is triggered.

As previously mentioned, a pulse through S_4 triggers the inhibit multivibrator (Q1-3 conducts, Q2-3 cut off). The collector voltage of Q1-3 (at +2 volts) performs four functions: (1) it locks the AND gate thus indicating a down-range step is in process (Q5 is cut off); (2) a positive level is sent out on the *carry out - zero set* lead resetting the BCD to zero and inhibiting the sign check FF thus preventing the start of a digitizing cycle during range switching; (3) a positive level is applied to the pullover line to prevent the indicator clear multivibrator from giving an indicator-clear signal; and (4) Q4-1 of the inhibit timing multivibrators is cut off.

The inhibit timing multivibrators (both are monostable) time the operation of the inhibit gate operation; due to the long duty cycle, two monostable multivibrators are used. When Q4-1 is cut off, approximately 50 milliseconds later it returns to its original state and triggers Q4-2. Again there is approximately a 50 millisecond delay and Q4-2 returns to its original state (conducting). Thus, after a delay of approximately 100 milliseconds, the positive collector potential of Q4-2 triggers the inhibit multivibrator by cutting off Q1-3. This removes the pullover voltage, the carry out 0-set signal and the positive potential from the AND gate lead. During the 100 millisecond delay, however, the TDVM gray-code counter has down ranged the instrument.

During the new conversion cycle, if the 1000's counter again registers a zero count the down-range procedure as described previously is repeated. Note that if the instrument is on the 1 volt range and a zero is read into the 1000's counter, that the only differentiator open is S_1; this has no effect since the multivibrator-1 is already in the 0 state. S_4 is not released so the inhibit gate is not triggered; the magnitude evaluation continues and the 1000's zero is displayed by the visual indicator.

When the instrument range is set manually, ground is removed from the emitter of Q5; thus, even though a pulse is passed by the AND gate, Q5 can not conduct and down-ranging is not initiated.

Figure 17 is a simplified logic diagram of the up-range portion of the 14.156-1 Unit. The necessity of up-ranging is indicated when the 1000's BCD records a 12 count. (With the 20% over-range capability of the TDVM the last visual indication on the readout system is 11.999; thus, a 12 in the 1000's counter indicates an overload.) As previously mentioned when the 1000's BCD reaches a 12 count, diodes CR17 and CR201 (Schematic Diagram D026 158 0S, Sheet 3) automatically shift the count to the 100's counter. At this time an up-range is indicated via the AND gate (Figure 17) if Q1-3 of the inhibit gate does not indicate that up-range switching action is already in process. From this point the action of the circuit is similar to that as described for the down range switching with the exception that the gray code counter is triggered to place the TDVM in the 1000 volt range. Thus despite what range the instrument is on, *the up-range circuit always sets the TDVM in the 1000 volt range,* and then, if necessary, the down range circuit seeks a lower range (if indicated by the input magnitude). For example, if the TDVM is on the 10 volt range and 100 volts is applied, the up-range circuit sets the instrument to the 1000's volt range and then the down range circuit will set the instrument in the 100 volt range. This feature assures a minimum duty cycle for the 100,000 ohm input resistor of the 1 and 10 volt range whenever an overload is indicated.

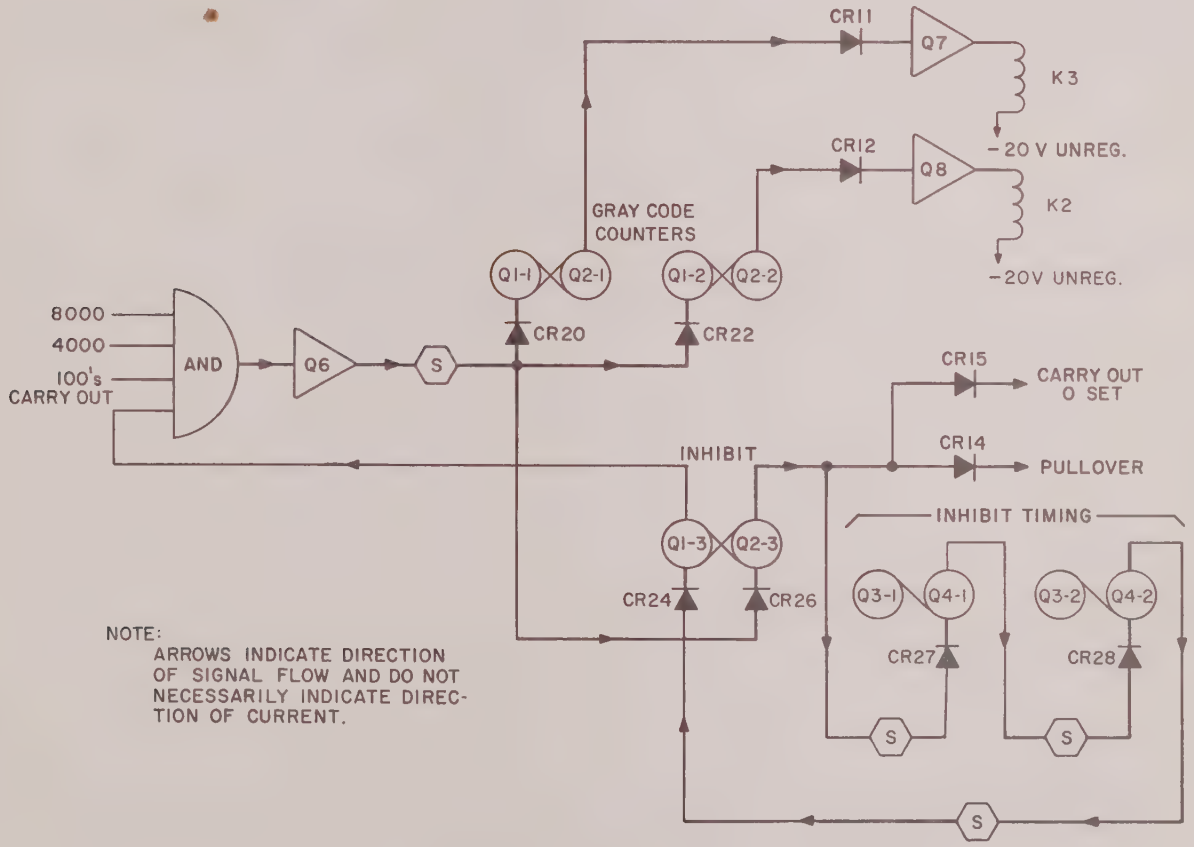


Figure 17. Up Range Circuit, Simplified Logic Diagram

The functions of the inhibit multivibrator and the inhibit timing multivibrators are identical to those described in the down-range sequence. The major difference between the down-range circuit and the up-range circuit functions is that during manual range selection the up-range circuit is still active. Thus, the up-range circuit acts as an overload protection circuit for manual range selection.

The function of the overload circuit is primarily to protect the 100,000 ohm input resistor on the 1 and 10 volt ranges. The 10 megohm resistor of the 100 and 1000 volt ranges can handle up to 500 volts continuous overload (and higher potentials for a short duty cycle) when the instrument is in the 100 volt range. For these reasons

the overload circuit controls only relay K2, de-energizing this relay when an overload is applied. The effect of controlling K2 is as follows: (1) if the TDVM is on the 100 volt range the instrument remains in this range but an overload lamp is lit; (2) if the TDVM is on the 10 volt range K2 is de-energized (TDVM reverts temporarily to the 100 volt range) and the overload lamp lights; (3) if the TDVM is on the 1 volt range K2 is de-energized (TDVM set temporarily to 1000 volt range) and the overload lamp lights. The TDVM remains in the temporary range for the 100 millisecond duty cycle of the inhibit multivibrator. As the inhibit multivibrator resets the TDVM will revert to the original manually selected range if the RANGE switch is not manually changed; however, after approximately 2 to 3 milliseconds the protection circuit will again place the instrument in the temporary higher range setting. The 2 to 3 millisecond overload when compared to the 100 millisecond period is sufficiently short for protection of the 100,000 ohm input resistor.

Figure 18 is a simplified diagram of the overload protection circuit. If an overload exists, thus triggering the inhibit multivibrator, Q9 is cut off (de-energizing K2, if energized) and Q10 conducts illuminating the overload lamp. The magnitude evaluation cycle is stopped (via CR14 and CR15) as previously described. The overload lamp shows up as a red spot on the left-hand side of the visual indicator thus signaling the operator to select a higher range*.

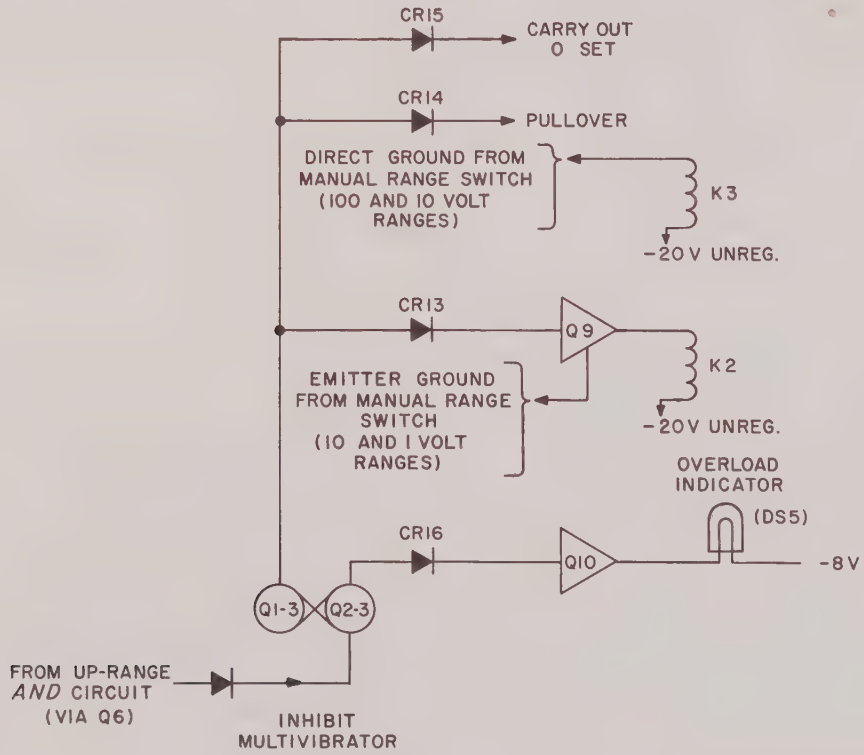


Figure 18. Manual Range Overload Protection Circuit, Simplified Logic Diagram

A 25 millisecond delay circuit is provided in the 12.1064 Network in conjunction with the automatic range circuit (Drawing C012 1064 0S). If there is a reversal of the input polarity, and the magnitude of the potential change is very large, the decay time of the d-c amplifiers may be sufficient to cause the TDVM to down-range prior to the amplifier output building up to the true magnitude of the new input. The instrument would then have to up-range and re-seek the proper range setting. To prevent this, a 25 millisecond monostable multivibrator (Q2 and Q3, Drawing C012 1064 0S) is triggered every time the sign multivibrator in the programmer changes state. The positive collector potential of Q2, together with a positive pulse from the range counter (Q1-1), is passed by an AND gate which cuts off Q13 (Drawing D014 156 0S). The negative potential of Q13 is inverted by Q14. The positive

**The overload indicator also lights when the instrument automatically up or down ranges; it indicates that the TDVM is inhibited during the time range changing occurs.*

output from Q14 sets the counter to the 1000V range and holds it there for 25 milliseconds. This delay gives the d-c amplifiers sufficient time to settle and then the range switching circuit is released (Q2 and Q3 re-set) and seeks the proper range. In addition, Q4 locks the *indicator clear* output so that the readout cannot change and give an erroneous display. This feature prevents false outputs when the TDVM is feeding external equipment.

The collector of Q1-1 is positive only when the gray code counter is in the 10V or 100V range (Table V); in the 1V range, the -10V at the collector of Q1-1 inhibits the AND gate, the output of Q14 stays negative and the counter holds in the 1V range. This inhibiting action thus prevents low-level transients, or a shift from plus to minus of the zero control (R2), from initiating up-ranging commands when the counter is in the 1V range.

4. CONTROL CIRCUITS

a. Remote Range Switching

The programming connector (P4) provides facilities for remote range selection of the 5001 TDVM. When the RANGE switch (S3) is placed in the REMOTE position, ground on the switch wiper is connected to terminal P4-3 (Drawing D026 158 0S, Sheet 2). By means of a wiper switch (similar to S3) or contact closures with P4-3 through P4-7 connected to the fixed contacts, the AUTO, 1000, 100, 10, and 1 volt range of the TDVM may be selected from a remote position. The operation of the TDVM is the same as when these ranges are selected by S3.

b. Single Cycle Trigger Mode

The operation of the TDVM in the previous description assumed the instrument was free running (TRIGGER switch in the INT HI position) and that the input was sampled at an average rate of 200 times per second. However, by placing the FUNCTION switch in the MAN position the TDVM will sample the input only when the TRIGGER switch on the front panel is depressed. The actual sample will be made at the normal TDVM sampling rate (5 millisecond average), but, the instrument will then stop and hold this readout until the TRIGGER switch is again depressed.

As shown on D026 158 0S, Sheet 2, depressing the Trigger switch applies +12 volts to Q13 of the single cycle multivibrator, cutting it off. This causes Q14 to conduct, cutting off Q10 (the pullover inverter) which permits the TDVM to take a normal sample. At the end of the sample, however, the carry-in signal from the units counter cuts off Q14 and the pullover inverter conducts thus preventing a new sample from being taken. Q14 remains in this state until the TRIGGER switch is again depressed. Note that when the FUNCTION switch is in the INT position (free running) a continuous +12 volts is applied to Q13 preventing the single cycle multivibrator (Q13 and Q14) from affecting the sampling operation.

Placing the FUNCTION switch in the EXT position permits remote control of the single cycle command circuit. Any positive going pulse of approximately 10 volts amplitude and 4 microseconds rise time is sufficient to trigger the TDVM.

c. INT LO Trigger Mode

When the trigger control is placed in the INT LO position, a trigger pulse is fed from an Astable Network 12.1022 (see Drawing B012 1022 0S) to Q13 of the Single Cycle Multivibrator. From this point the sampling cycle is identical to the MAN cycle except that a normal sample is taken at the rate of 2 times every second rather than at the discretion of the operator.

d. External Hold Circuit

The sampling rate of the TDVM is faster than the operating capabilities of most accessory equipment used in conjunction with it. This is true in the case of the EAI high-speed printer; the printer cycles at a rate of 3 operations per second (compared to the average of 200 operations per second of the TDVM).

An external *hold* input (P1-68, Diagram D026 158 0S, Sheet 2) is provided for the TDVM to permit the external equipment to hold a TDVM reading.

A negative potential (approximately -12 volts) applied to P1-68 clamps the indicator-clear gate in the conducting state. This prevents clearing the storage circuits, thus holding the readout data until the negative potential is removed. The hold voltage *does not* stop the continuous sampling operation of the TDVM in any other respect.

The readout data (on plug P1) for external use is available in both binary-coded decimal or straight decimal form. Thus the TDVM readout capabilities can be used with a multitude of external accessory equipment and is an especially fast analog-to-digital converter.

5. REFERENCE CIRCUITS AND POWER SUPPLIES

a. Reference Amplifier 6.464-4

This unit consists of a stable voltage element and a chopper-stabilized d-c amplifier; it functions as a -100 volt stable reference source. (See Drawing D026 158 0S, Sheet 1 for a simplified schematic diagram of this unit.)

The stable voltage source consists of a zener diode regulating network connected across the +40 volt supply. The diodes provide a stable potential of approximately 9.4 volts. This voltage is applied through R1 (NW6) to the input of the d-c amplifier (AR2). The amplifier gain (determined by the ratio of the feedback to input resistance) is adjusted to yield a -100 volt output. The -100 volt regulated output is the reference source applied to the common side of the summing resistors in the 26.116-1 Network.

The reference amplifier (AR2) utilizes a conventional automatic balancing circuit consisting of a 60 cycle vibrator and a three-stage, high-gain, a-c amplifier. Manual balance control is provided by R9 (Drawing D006 464 0S).

b. Power Distribution

The 5001 Series TDVM operates directly from a commercial 117/230 volt, 50 or 60 cycle source.

Schematic Diagram D026 158 0S, Sheet 4 shows the input a-c lines, the various rectifiers, and the associated regulator circuits (in block form). In addition, the distribution of the various d-c and a-c potentials is shown.

Detailed circuitry of all of the regulators (except Q1 through Q5 of the reference source), is shown on Schematic Diagram C043 126 0S. The reference regulator is shown in detail on Schematic Diagram D006 464 0S.

The power circuits of the TDVM supply the following d-c voltages: -100 volts, -110 volts, ±20 volts, ±12 volts, -8 volts, +40 volts, and +2 volts. The power circuits also energize the cooling fan and supply 6.3 volts a-c to the following circuits: the reference amplifier chopper, the dual d-c amplifier chopper, and the heater elements of the oven on the Comparator and Diode Gate and the reference supply break-down (Zener) diode oven.

CHAPTER V

MAINTENANCE

1. GENERAL CONSIDERATIONS

To assist the maintenance technician this chapter contains instructions on trouble analysis, printed circuit and transistor servicing techniques. Also included in this handbook are replaceable parts lists (Appendix I), schematic and wiring diagrams (Appendix II), and general information on servicing techniques (Appendix III).

It should be noted that these maintenance instructions and data cannot cover all possible troubles and malfunctions; it is, therefore, essential that maintenance personnel be thoroughly familiar with the TDVM circuitry. General purpose maintenance data cannot be substituted for technical knowledge of the instrument.

2. TEST POINT CONNECTOR

As previously indicated, a TEST POINT Connector (P2) is mounted on the rear panel to permit monitoring instruments to be connected to certain circuit points in the TDVM. The connector terminations may be used directly or these points may be cabled to a central monitoring facility.

One suggested method of utilizing the TEST POINT connector for trouble-shooting purposes is to make comparisons between test-point potentials of an operational instrument and a malfunctioning instrument. In cases where only one instrument is available, all test point potentials should be measured and recorded when the instrument is first placed in service. Thus, if trouble occurs at a later time, the recorded set of normal voltages can aid in trouble-shooting.

Table VI lists all terminations of the connector, the circuit or source of the voltage at each terminal, and the circuit utilizing the particular voltage.

CAUTION

Do not short-circuit the -100 volt reference line to ground.

3. TROUBLE ANALYSIS

This paragraph lists some general techniques for trouble-shooting should a malfunction occur in the TDVM. Again it should be noted that not all possible areas can be covered and that the maintenance technician must fully understand the circuit operation of this instrument.

To assist in analyzing a malfunction, each circuit of the TDVM should be considered as being in one of three main groups: the input amplifiers with associated circuitry, the closed-loop logic circuits (including the indicator bank), and the power and reference supplies and regulators.

Trouble analysis is best accomplished by observing the action of the indicators and relating this action to possible causes of trouble. Accordingly, the suggested trouble-shooting procedures in the following paragraphs are grouped as to indicator display.

a. Indicators Displaying Fixed Reading

If a fixed reading is displayed regardless of the input, the most likely source of trouble is the logic circuitry. The following steps outline one suggested method of locating a malfunction of this type.

(1) Check the Programmer for the presence of either *count* or *shift* pulses at pin P (shift) or S (count) of connector A6-J1.

(2) If one or the other is *not* present, check for blocking-oscillator output pulses. The output frequency may be checked by using a calibrated time-base oscilloscope, and should be between 5 and 9 kc. If the blocking oscillator is functioning correctly, check the double AND gate consisting of Q1, Q2, and Q3 on the Programmer.

TABLE VI. Test Connector Terminations

CONNECTOR TERMINAL	CIRCUIT	VOLTAGE OR FUNCTION
1	Reference Amplifier Balance	For adjustment of Reference Amplifier Balance
2	-100V Reference	-100V d-c ±0.005%
3	+40 Power Supply Regulator	+40V d-c ±1%
4	Reference Zener Check	+9.4V d-c ±10%
5	-20 Power Supply Regulator	-20V d-c ±1%
6	-110 Power Supply Regulator	-110V d-c ±1%
7	Indicator Clear	See waveform *h* on Figure 7.
8	Amplifier-A Output	Determined by input and range setting.
9	Amplifier-B Output	Determined by input and range setting.
10	+2V Power Supply Regulator	+2V d-c ±10%
11	+12V Power Supply Regulator	+12V d-c ±10%
12	+20V Power Supply Regulator	+20V d-c ±1%
13	-8V Power Supply Regulator	-8V d-c ±10%
14	-12V Power Supply Regulator	-12V d-c ±10%
15	Carry-In Line	-10V level with one +2.0V, 200 microsecond pulse per sampling cycle.
16	± Ground	
17	Amplifier-B Balance	See Paragraph 2*b*, Chapter III.
18	Amplifier-A Balance	See Paragraph 2*c*, Chapter III.

(3) If *count* or *shift* pulses are present, check the Q11-Q12 multivibrator on each of the BCD counters. (See Timing Diagram, Figure 7.) If necessary replace each BCD card in turn with a spare card known to be operational. (Interchanging the existing cards in the TDVM will not accomplish the desired check, since *all four cards are in closed loop.)*

b. Indicators Displaying All Zeros

An all-zero display regardless of the input generally indicates a malfunction in the input amplifiers or the comparator and associated circuits. Check as follows:

(1) Apply a positive input to the TDVM and monitor the output of each d-c amplifier at the TEST POINT connector. The first amplifier (AR1-b) output is at terminal 8, and the second amplifier (AR1-a) output appears on terminal 9.

(2) If the amplifiers are functioning normally, remove the Summing Resistor Network (NW-2) and check for positive voltage at pin 12 of relay K1. If a negative voltage appears at this point, check the relay, and the following Programmer circuits: Sign Check Multivibrator (Q11-Q12), Sign Multivibrator (A6-Q7), and the Relay Amplifier (Q5).

(3) If voltage at K1-12 is normal (positive), change the polarity of the TDVM input signal, and again check for positive voltage at K1-12. If this point is now negative check all circuits listed in sub-paragraph (2).

(4) If the voltage at K1-12 remains positive *after* changing the input polarity, proceed to the comparator. Under the present conditions the *Comp Out* - line should be at -10 volts, and the Comp Out + line close to zero.

(5) If all of the previously-listed circuits appear to be functioning normally the trouble may be in one of the BCD Counter cards. This can be verified by replacing each card in turn with a card known to be operational.

c. Indicators Display Continually-Changing Random Digits

A display of this type usually indicates that the logic circuitry is functioning properly, but that trouble exists in the input circuits. Proceed as follows:

(1) Remove relay K1 and attempt to zero-set the instrument.

(2) If zero-setting can be accomplished, the input amplifiers and associated circuitry should be checked.

d. Two-Digit Display on One Indicator

If one of the indicators displays two digits simultaneously, the usual cause is diode leakage in the BCD-to-decimal converter section of a Readout Storage Decade. This is verified by the appearance of certain combinations of digits such as 8 and 9, 3 and 5, etc.

NOTE

Noise on the input signal may cause one or more of the indicators to flicker between digits.

e. Blurred Readout Display Digit

Should a particular digit of a display window appear blurred (or fuzzy) the cause is usually due to the filament of the lamp, which illuminates the digit, being off center. This condition can normally be corrected by removing the particular lamp, rotating it 180°, and re-inserting in the socket; in some instances the bulb may have to be replaced.

CHAPTER VI

CALIBRATION

1. INTRODUCTION

This chapter contains instructions and procedures for complete calibration of the 5001. As previously indicated, each instrument is completely calibrated prior to shipment and should not require any adjustments upon receipt. If, however, it later becomes necessary to replace any components which affect the accuracy or calibration of the instrument, re-calibration is necessary.

Calibration of an instrument with the accuracy of the 5001 is an exacting procedure requiring precision equipment and extremely stable voltage sources not normally available in field installations. Unless such equipment is available, EAI recommends that the instrument be returned to the factory if re-calibration becomes necessary.

2. REQUIRED EQUIPMENT

The equipment listed in the following table is required to completely re-calibrate the 5001 to the original factory specifications.

TABLE X. Required Test Equipment

Component	Recommended Type	Used For
Precision Ratio Bridge (accurate to 0.001%)	Julie SCRS 505 Voltage Reference Set (or equal)	Reference Adjustment
Precision Voltage Divider (6-place)	Julie VDR 106 (or equal)	DC Gain Adjustment - Summing Network Trimming Adjustment
Galvanometer (capable of detecting 1/10 microvolt or better)	Hewlett-Packard, Model 425A (or equal)	Reference Adjustment - DC Gain Adjustment - Summing Network Trimming Adjustment
Microammeter (capable of reading 0.004 microamp)	Hewlett-Packard, Model 425A (or equal)	Unloading Adjustment
Secondary Standard Voltage Cell (calibrated to 0.002%)	Epley MIN III calibrated against a primary standard (or equal)	Reference Adjustment
Two 30,000 Ohm Ten-Turn Potentiometers	Helipot, Model 30,000 - A1 (or equal)	Summing Network Trimming Adjustment
Stable DC Source (stable to +0.005%)		DC Gain Adjustment - Summing Network Trimming Adjustment

3. PRELIMINARY PROCEDURES

Before proceeding with the calibration procedure outlined in Paragraph 4, the preliminary checks and adjustments in this paragraph should be performed. This will ensure that the TDVM is functioning normally with all amplifiers balanced and power supply outputs at the correct levels.

Proceed as follows:

a. Remove the TDVM from the rack or dust cover. Apply line voltage through an autotransformer, so that the applied primary voltage may be varied, as follows: hot lead to P3-0, common to P3-9, and chassis ground to P3-5.

b. Set the input to 117 volts ac and permit the TDVM to warm-up for two hours with the power control switch in STANDBY.

c. Using a VTVM (accurate to better than ±1%) check (and adjust if necessary) the following dc operational voltages: ±40v, ±20v, ±12v, -8v, +2v, and -110v. All voltages except the +40, ±20 and -110 volt outputs should be within 10% of the rated level with the line voltage first set at 105 volts and then at 125 volts. The +40 and ±20 volt and -110 volt levels should be within 1% of the rated value. Reset the line level to 117 volts.

d. Balance each of the dc amplifiers as outlined in Paragraph 2*b.*, Chapter III. Balance the reference amplifier in the same manner, connecting the meter between pins 1 and 16 of the of the TEST POINT connector (P2) and adjusting R9 on the Reference Amplifier card.

This completes the pre-calibration checks and adjustments; the instrument is now ready for the calibration procedure described in the following paragraphs.

4. CALIBRATION PROCEDURE

The adjustments listed in this paragraph should be made in the order given.

a. Reference Amplifier Adjustment

Set up the test circuit as illustrated in Figure 19. (The setting of the ratio bridge is determined by the actual potential of the standard cell.)

Adjust R12 on the Reference Amplifier 6.464-4 until a null is obtained on the galvanometer. This adjustment sets the reference at 100 volts ±0.005%. (For the physical location of R12 see the Reference Amplifier 6.464-4 component location diagram.)

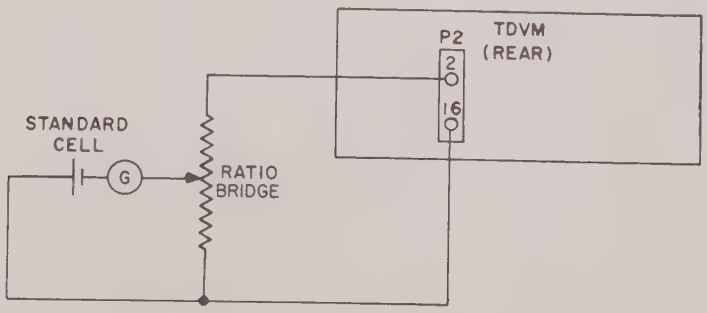


Figure 19. Reference Adjustment, Test Setup

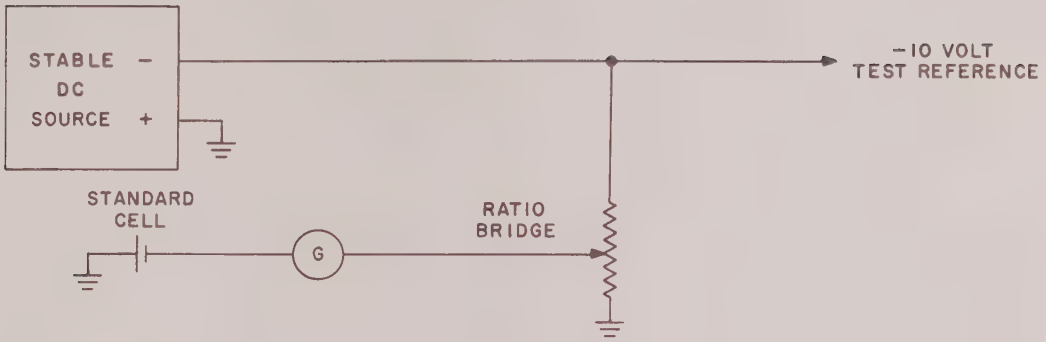


Figure 20. -10 Volt Test Reference, Calibration Setup

b. Test Reference Calibration

Use the following procedure to calibrate the stable dc source for use in later procedures.

(1) Set up the test circuit shown in Figure 20. (The setting of the ratio bridge is determined by the actual potential of the standard cell.)

(2) Adjust the stable dc source for a null on the galvanometer. This adjustment sets the test reference voltage at -10 ±0.005%.

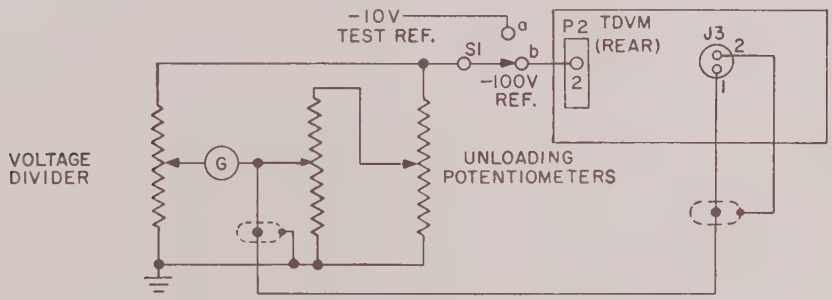


Figure 21. Full Scale and Trim Pot Adjustment, Test Setup

c. Full Scale Adjustment

(1) Set up test circuit as shown in Figure 21.

(2) Reset ZERO adjustment.

(3) Set the TDVM range switch to the 100 volt position (manual range setting).

(4) Set switch S1 to position a.

(5) Set the voltage divider for -7.775 volts; adjust the test circuit unloading potentiometer for a galvanometer null.

(6) Adjust the FULL SCALE ADJ potentiometer (R14) on the 12.1064 Network Card NW7 for a displayed reading that flickers between -7.77 and -7.78 volts.

NOTE

The display should remain constant over a wide range of the FULL SCALE ADJ potentiometer. Set the potentiometer in the center of this range.

(7) Switch the TDVM to STANDBY and re-check the Zero adjustment.

d. Summing Resistor Trim Pot Adjustment

Use the test set up shown in Figure 21. These adjustments should not be attempted until the ZERO adjustment (Paragraph *c.*, Step (7) check is made. Re-check the ZERO adjustment (in the STANDBY mode) after each of the procedural steps outlined in this paragraph. Each of the following steps should be performed with the TDVM set on the 100 volt range.

The trim pot physical locations are shown on the Summing Resistor Network 26.116-1 component location diagram.

(1) *8000 Trim Pot Adjustment*

(a) Set switch S1 to position b.

(b) Apply an input of -80.015 volts to the TDVM.

(c) Adjust R9p (NW2) until the TDVM readout flickers between -80.01 and 80.02*.

(d) Set the TDVM to STANDBY and re-check the ZERO setting.

(2) *4000 Trim Pot Adjustment*

(a) Apply an input of -40.015 volts to the TDVM.

(b) Adjust R11p (NW2) until the TDVM readout flickers between -40.01 and -40.02.

(c) Set the TDVM to STANDBY and re-check the ZERO setting.

(3) *2000 Trim Pot Adjustment*

(a) Apply an input of -20.015 volts to the TDVM.

(b) Adjust R13p (NW2) until the TDVM readout flickers between -20.01 and -20.02.

(c) Set the TDVM to STANDBY and re-check the ZERO setting.

(4) *1000 Trim Pot Adjustment*

(a) Apply an input of -10.015 volts to the TDVM.

(b) Adjust R15p (NW2) until the TDVM readout flickers between -10.01 and -10.02.

(c) Set the TDVM to STANDBY and re-check the ZERO setting.

(5) *800 Trim Pot Adjustment*

(a) Set switch S1 to position a.

**Approach the settings from the high side, i.e., 80.03, 80.02, and then to the flickering state.*

(b) Apply an input of -8.015 volts to the TDVM.

(c) Adjust R10p (NW2) until the TDVM readout flickers between -8.01 and -8.02.

(d) Set the TDVM to STANDBY and re-check the ZERO setting.

(e) Apply an input of -87.77 volts and check the FULL SCALE ADJ setting. If this adjustment requires resetting, repeat Steps (1) through (5).

e. DC Gain Adjustment

(1) Set up the test circuit as shown in Figure 21, apply an input of -8.775 volts.

(2) Set the TDVM to the 10 volt scale.

(3) Adjust the input voltage to -8.776, and back to -8.775. Note the span on the voltage divider dial, and set the dial to the center of this span.

(4) Apply a positive potential *equal in magnitude* to the potential used in Step (3) to the TDVM input.

(5) Adjust R20 (NW7) for a readout equal to the recorded value in Step (3).

(6) Repeat Steps (3) through (5).

f. TDVM Unloading

(1) Set up the test circuit illustrated in Figure 22. (The switch by-passing the meter permits setting the voltage divider without subjecting the meter to excessive current flow.)

(2) Set the TDVM to the 10 volt range and apply an input of -10.00 volts.

(3) Set the INPUT IMPEDANCE switch to MAX and open the meter bypass switch.

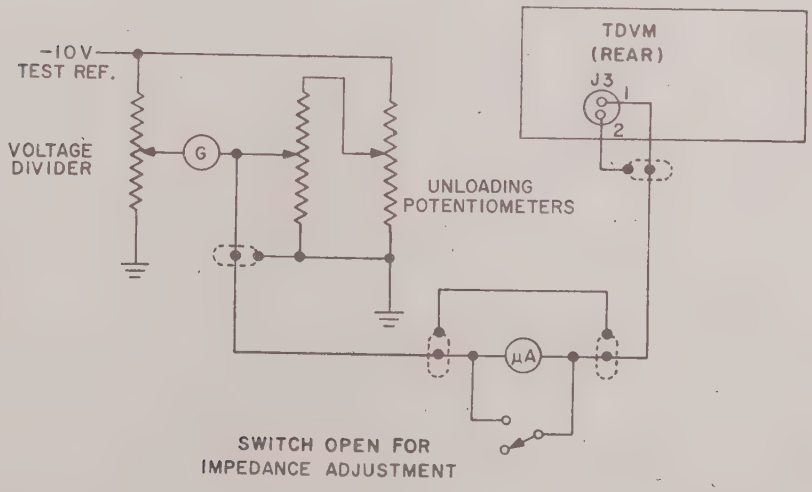


Figure 22. TDVM Unloading Adjustment, Test Setup

(4) Adjust R4 (NW7) for minimum current through the microammeter (maximum allowable reading of 0.02 microamperes). This sets the input impedance to 500 megohms or greater. (Be sure the current measured on the microammeter is from the source voltage. Improper adjustment can cause the input amplifier circuit to appear as a negative impedance.)

(5) Switch the INPUT IMPEDANCE switch to the 10M position (with the 10 volts still applied).

(6) Adjust R3 (NW7) for 1 microampere of current. This sets the input impedance to 10 megohms.

(7) Close the meter bypass switch and set the TDVM to the 1 volt range. Apply an input of 1.000 volt.

(8) Set the INPUT IMPEDANCE switch to the MAX position. Open the bypass switch and adjust R2 (NW7) for minimum current through the microammeter (maximum allowable reading of 0.004 microamperes). This sets the input impedance to 250 megohms or greater.

(9) Switch the INPUT IMPEDANCE switch to the 10M position.

(10) Adjust R1 (NW7) for 0.1 microampere of current. This sets the input impedance to 10 megohms.

APPENDIX I

REPLACEABLE PARTS LISTS

This appendix lists all replaceable parts in the 5001 Transistorized Digital Voltmeter. In each case a brief description of the part and a manufacturer's number are listed. Where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, and index page precedes the individual spare parts lists.

The category column in the parts list is intended to indicate the availability of each listed part so that a replacement part can be obtained as quickly as possible. The components in category-A are standard electronic items that are usually available from any commercial electronic supplier. In order to expedite obtaining items of this nature, it is suggested that they be purchased from a local source whenever possible. If necessary these parts may be ordered from EAI.

The components in category-B are items that can be obtained from EAI or any of the listed manufacturers. However, in most cases EAI is in a position to offer the most rapid service on items in this category.

The parts in category-C are custom-made components and proprietary items that are available only from EAI. When ordering items of this type, please specify the type number and serial number of the basic unit in which the part is located, as well as the part identification.

Where possible, sufficient information is given for category-C items to permit an *electrically-similar* replacement part to be obtained locally. Thus, if desired, a temporary repair may be made while the *exact* replacement is being obtained from EAI. *Note, however, that EAI does not guarantee that the affected unit will operate within specifications when the specified category-C part is not used.*

PLEASE NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. IN ALL CASES EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LIST INDEX

5001 TRANSISTORIZED DIGITAL VOLTMETER, MODEL 26.158

Model Number	Component	Page
1. 26.158	5001 TDVM (Automatic Range Switching)	AI-3
2. 6.463-1	Dual DC Amplifier	AI-5
3. 6.464-4	Reference Amplifier	AI-8
4. 12.675	Diode Network	AI-11
5. 12.1064	Network Card	AI-12
6. 12.722	Reference Amplifier Network	AI-15
7. 14.156-1	Automatic Range Switching Circuits	AI-16
8. 26.096-4	Comparator and Diode Gate	AI-18
a. 26.134-3	Comparator Amplifier	AI-18
9. 26.116-1	Summing Resistor Network	AI-19
10. 43.126-1	Power Supply Regulator	AI-21
11. 44.139	Binary Coded Decade Counter	AI-23
12. 44.139-4	Binary Coded Decade Counter	AI-24
13. 44.170-4	Programmer	AI-25
14. 51.010	Readout Storage Decade	AI-27
15. 51.080-5	Readout Storage Decade	AI-28

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	B1	Fan, Muffin Venturi: 110V 60 CPS, 13 Watts; Rotron Mfg. Co.	B242 022 1	C
2	C1	Capacitor, Fixed, Electrolytic: 4000 UF, 15V; Sprague TVL-1173	516 044 0	A
3	C2	Capacitor, Fixed, Electrolytic:(Dual): 200-200 UF +100% -10%, 250V; P.R. Mallory FP217.74	516 139 0	A
4	C3-5	Capacitor, Fixed, Electrolytic: 2000 UF, 50V; P.R. Mallory WP TS-17123	516 239 0	B
5	C6	Capacitor, Fixed, Paper: .5 UF ±10%, 600V; Sprague BP506	520 074 0	A
6	CR1-4	Rectifier, Silicon: Hughes Semiconductor HR10212	614 034 0	B
7	DSI-4	Digital Display Indicator: Industrial Electronic Engineers, Inc. 10984-47	B554 016 0	C
8	DS5	Digital Display Indicator: Industrial Electronic Engineers, Inc. 10K61-47B	C554 022 1	C
9	F1	Fuse, Cartridge, Slow Acting Type: 1 Amp, 125V; Littelfuse 313001	570 111 0	A
10	K1	Relay: 430 ohm DC Coil, 4 Form C Contacts; Allied Controls T-154X-158	B618 157 1	C
11	K2,3	Relay: 24 VDC Coil, 4 Form C Contacts; C.P. Clare Type J Code 22 A296341	B618 165 0	C
12	NW1	Resistor Network	C012 725 0	C
13	Q1-4	Transistor, Germanium: PNP; Bendix 2N1136A	686 066 0	B
14	R1-S4	Switch, Rotary and Resistor, Variable: 10K ohms	C658 228 0	C
15	R2,3	Resistor, Variable, Composition: 10K ohms ±20% 1/2W; Allen-Bradley Type G	A642 364 0	A
16	R5,6	Resistor, Fixed, Wirewound: 20 ohms ±5%, 10W; Milwaukee Resistor Co.	C636 421 0	B
17	R7	Resistor, Fixed, Wirewound: 33 ohms ±5%, 2W; Ward Leonard 2X33	636 425 0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
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DATE 9 / 18 / 63

UNIT TITLE

AUTO RANGE SWITCHING TDVM

MODEL NO.

26.158 Sh.1 of 2 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
18	R8	Resistor, Fixed, Wirewound: 100 ohms ±5%, 10W; Milwaukee Resistor Co.	C636 422 0	B
19	R9	Resistor, Fixed, Wirewound: 82 ohms ±5%, 2W; Ward Leonard 2X82	636 426 0	A
20	R10,12	Resistor, Fixed, Composition: 6.8 ohms ±5%, 1W; Allen-Bradley GB	627 689 0	A
21	R11	Resistor, Fixed, Wirewound: 3 ohms ±5%, 10W; Hardwick-Hindle 3/4-BRS-538	C636 445 0	B
22	R13	Resistor, Fixed, Composition: 6.8K ohms ±10%, 2W; Allen-Bradley HB	628 682 1	A
23	R14	Resistor, Fixed, Composition: 470 ohms ±10%, 1/2W; Allen-Bradley EB	626 471 1	A
24	S2	Switch, Toggle: DPDT; Microswitch 6AT3	664 029 0	B
25	S3,8	Switch, Rotary (Dual): 2 Sections; Centralab 31-1091-2	C658 194 0	C
26	S5,7	Switch, Function: Centralab PA-037 and Grayhill, Inc. 23-1	C658 224 0	C
27	T1	Transformer, Power: 105V/117V/125V, 50/60 cps primary, 2 ea. 39 VCT, 1 ea 36 VCT, 1 ea. 6.3V and 1 ea. 220 VCT secondaries; Sterling ST26280	B684 172 0	C

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DATE 9 / 18 / 63

UNIT TITLE

AUTO RANGE SWITCHING TDVM

MODEL NO.

26.158 Sh.2 of 2 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1,10	Capacitor, Fixed, Electrolytic: .47 UF, 50V	B521 133 0	C
2	C2,9,11,18	Capacitor, Fixed, Electrolytic: 1250 UF +100%, -10%, 3V; Callins Industries, Inc. PSS Series	A516 184 0	C
3	C3,12	Capacitor, Fixed, Ceramic: 100 PF ±10%, 1000V; Cornell-Dubilier L10T1	515 019 0	A
4	C4,13	Capacitor, Fixed, Ceramic: .015 UF ±20%, 500V; Sprague Electric 33C30A	515 140 0	B
5	C5,14	Capacitor, Fixed, Ceramic: 47 PF ±10%, 1000V; Cornell-Dubilier L10Q47	515 017 0	A
6	C6,15,19,20	Capacitor, Fixed, Ceramic: 1000 PF ±20%, 75V; Glenco Min-Z-1000-M	515 075 0	B
7	C7,16	Capacitor, Fixed, Electrolytic: .22 UF, 50V	B521 134 0	C
8	C8,17	Capacitor, Fixed, Electrolytic: 4.7 UF ±10%, 35V; Sprague Products 150D475X9035B2	516 246 0	A
9	C21,22	Capacitor, Fixed, Ceramic: 8 PF ±10%, 1000V; Cornell-Dubilier C10V8C	515 087 0	A
10	C23,24	Capacitor, Fixed, Ceramic: .05 UF +100%, -20%, 30V; Centralab DA-503	515 183 0	A
11	CR1-4,9,10	Rectifier, Silicon: Hughes Semiconductor 1N452	B614 007 0	B
12	CR5-8	Diode, Germanium: Clevite CTP462	614 043 0	B
13	D1	Chopper: 6.3V 60 CPS Coil, DPDT BBM Contacts; James Electronics C-2335	530 042 0	C
14	DS1-4	Lamp, Incandescent: General Electric 330	578 020 0	A
15	Q1,2,9,10	Transistor, Germanium: PNP; General Transistor Corp. CT1236	B686 028 0	C
16	Q3,4,11,12	Transistor, Germanium: PNP; Motorola 2N652	686 084 0	B
17	Q5,13	Transistor, Silicon: NPN; General Electric 4JX118816	C686 112 0	C
18	Q6,7,8,14, 15,16	Transistor, Germanium: PNP; Industro	B686 096 0	C

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DATE 5 / 27 / 63

UNIT TITLE

DUAL DC AMPLIFIER

MODEL NO.

6.463-1 Sh. 1 of 3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
19	Q17-19,21	Transistor, Germanium: NPN; 2N169A Type	686 036 0	A
20	Q20,22	Transistor, Germanium: NPN; Texas Instruments 2N1308	686 101 0	B
21	R1,27	Resistor, Fixed, Composition: 3.3 Megohms ±10%, 1/2W; Allen-Bradley EB	626 335 1	A
22	R2,28	Resistor, Fixed, Composition: 3.3K ohms ±10%, 1/2W; Allen-Bradley EB	626 332 1	A
23	R3,35	Resistor, Fixed, Composition: 1.8K ohms ±10%, 1/2W; Allen-Bradley EB	626 182 1	A
24	R4,36	Resistor, Fixed, Composition: 2.2K ohms ±10%, 1/2W; Allen-Bradley EB	626 222 1	A
25	R5,29	Resistor, Fixed, Composition: 1.6K ohms ±5%, 1/2W; Allen-Bradley EB	626 162 0	A
26	R6,37	Resistor, Fixed, Composition: 8.2K ohms ±5%, 1/2W; Allen-Bradley EB	626 822 0	A
27	R7,30	Resistor, Fixed, Composition: 100 ohms ±10%, 1/2W; Allen-Bradley EB	626 101 1	A
28	R8,31	Resistor, Fixed, Composition: 3.3K ohms ±5%, 1/2W; Allen-Bradley EB	626 332 0	A
29	R10,33	Resistor, Fixed, Composition: 150K ohms ±10%, 1/4W; Allen-Bradley CB	625 154 1	A
30	R11,15,25, 26,34,39, 51,52,53,54	Resistor, Fixed, Composition: 100K ohms ±10%, 1/2W; Allen-Bradley EB	626 104 1	A
31	R12,40	Resistor, Fixed, Composition: 33K ohms ±10%, 1/2W; Allen-Bradley EB	626 333 1	A
32	R13,41	Resistor, Fixed, Composition: 5.6K ohms ±5% 1/2W; Allen-Bradley EB	626 562 0	A
33	R14,38	Resistor, Fixed, Composition: 560K ohms ±10%, 1/2W; Allen-Bradley EB	626 564 1	A
34	R16,17,46, 48	Resistor, Fixed, Composition: 22K ohms ±10%, 1/4W; Allen-Bradley CB	625 223 1	A
35	R18,50	Resistor, Fixed, Composition: 3.9K ohms ±10%, 1/4W; Allen-Bradley CB	625 392 1	A

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UNIT TITLE

DUAL DC AMPLIFIER

MODEL NO.

6.463-1 Sh. 2 of 3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
36	R21,22,42, 43	Resistor, Fixed, Composition: 47K ohms ±10%, 1/2W; Allen-Bradley EB	626 473 1	A
37	R23,45	Resistor, Fixed, Composition: 270K ohms ±10% 1/2W; Allen-Bradley EB	626 274 1	A
38	R57,58	Resistor, Fixed, Composition: 150 ohms ±10%, 1/2W; Allen-Bradley EB	626 151 1	A
39	R59,60	Resistor, Fixed, Composition: 56K ohms ±10%, 1/2W; Allen-Bradley EB	626 563 1	A
40	R61,62	Resistor, Fixed, Composition: 47 Megohms ±10%, 1/2W; Allen-Bradley EB	626 476 1	A

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DATE 5/ 27/ 63

UNIT TITLE

DUAL DC AMPLIFIER

MODEL NO.

6.463-1 Sh. 3 of 3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1	Capacitor, Fixed, Electrolytic: 55 UF +20% -15%, 15V; Sprague 109D556C2015F2	516 188 0	B
2	C3,5	Capacitor, Fixed, Ceramic: 100 PF ±10%, 1000V; Cornell-Dubilier L10T1	515 019 0	A
3	C4,6,20	Capacitor, Fixed, Ceramic: .01 UF +60% -40%, 150V; Centralab DDM-103	515 151 0	A
4	C8	Capacitor, Fixed, Electrolytic: 5 UF +20% -15%, 50V; Sprague 109D505C2050C2	516 186 0	B
5	C9,11	Capacitor, Fixed, Electrolytic: 1250 UF +100% -10%, 3V; Callins Ind. PPS Series	A516 184 0	C
6	C10	Capacitor, Fixed, Electrolytic: 5 UF +100% -10%, 25V; Callins Industries PSS Series	A516 182 0	C
7	C23,27	Capacitor, Fixed, Ceramic: 1000 PF GMV, 600V; Cornell-Dubilier BYA6D1	515 005 0	A
8	C24	Capacitor, Fixed, Ceramic: 2200 PF GMV, 1000V; Cornell-Dubilier BYA10D22	515 006 0	B
9	CR1,2	Rectifier, Silicon: Solitron Devices CER71C	614 137 0	B
10	CR3	Dioe, Silicon: Zener; Texas Instrument 1N759	614 091 0	B
11	CR4,5	Rectifier, Silicon: Hughes Semiconductor HR10212	B614 007 0	B
12	CR6	Diode: Germanium; Clevite CTP462	614 043 0	B
13	CR10	Diode, Silicon: Zener; Motorola 3/4M47Z10	614 138 0	B
14	D1	Chopper: 6.3V 60 CPS Coil, BBM; SPDT Contacts Airpax A-175	530 003 0	C
15	Q1	Transistor, Germanium: PNP; Bendix 2N1136A	686 066 0	B
16	Q2,3,7,12	Transistor, Germanium: PNP; General Electric 2N321 Type	686 004 0	A
17	Q5,9,10	Transistor, Germanium: PNP; Industro	B686 032 0	B
18	Q6,11	Transistor, Germanium: PNP; Motorola 2N652	686 084 0	B
19	Q8	Transistor, Germanium: PNP; 2N235A Type	686 034 0	A
20	R1,29,35	Resistor, Fixed, Composition: 22K ohms ±10%, 1/2W; Allen-Bradley EB	626 223 1	A

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THE PROPER EAI PART SHOULD BE INSTALLED FOR CATEGORY C ITEMS. A COMPLETE DESCRIPTION IS GIVEN TO PROVIDE FOR TEMPORARY REPAIRS; HOWEVER, EAI WILL NOT BE RESPONSIBLE IF UNIT IS NOT WITHIN SPECIFICATIONS UNDER THESE CONDITIONS.

DATE 9 / 6 / 63

UNIT TITLE

REFERENCE AMPLIFIER

MODEL NO.

6.464-4 Sh. 1 of 3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
21	R2	Resistor, Fixed, Composition: 27K ohms ±10%, 1W; Allen-Bradley GB	627 273 1	A
22	R3,26,45	Resistor, Fixed, Composition: 2.7K ohms ±10%, 1/2W; Allen-Bradley EB	626 272 1	A
23	R4,7	Resistor, Fixed, Composition: 15K ohms ±10%, 1W; Allen-Bradley GB	627 153 1	A
24	R5	Resistor, Fixed, Composition: 1.2K ohms ±10%, 1/2W; Allen-Bradley EB	626 122 1	A
25	R6	Resistor, Variable, Wirewound: 2K ohms ±10%, .25W; Bourns Laboratories 200L-1-202	642 080 0	B
26	R8,22,33,37	Resistor, Fixed, Composition: 68K ohms ±10%, 1/2W; Allen-Bradley EB	626 683 1	A
27	R9	Resistor, Variable, Wirewound: 10K ohms ±10%, .25W; Bourns Laboratories 200L-1-103	642 082 0	B
28	R10	Resistor, Fixed, Film: 3300 ohms ±1%, 1/2W; International Resistance Corp. DCC Type	634 293 0	B
29	R12	Resistor, Variable, Wirewound: 200 ohms ±5%, 1W; Daystrom Pacific Corp. 300-00 Type	B642 201 0	B
30	R13	Resistor, Fixed, Composition: 1K ohms ±10%, 1/2W; Allen-Bradley EB	626 102 1	A
31	R15,17,39	Resistor, Fixed, Composition: 4.7K ohms ±10%, 1/2W; Allen-Bradley EB	626 472 1	A
32	R16	Resistor, Fixed, Composition: 3.3K ohms ±10% 1/2W; Allen-Bradley EB	626 332 1	A
33	R18	Resistor, Fixed, Composition: 12K ohms ±10%, 1/2W; Allen-Bradley EB	626 123 1	A
34	R19	Resistor, Fixed, Composition: 33K ohms ±10%, 1/2W; Allen-Bradley EB	626 333 1	A
35	R20	Resistor, Fixed, Composition: 1.8K ohms ±5%, 1/2W; Allen-Bradley EB	626 182 0	A
36	R21	Resistor, Fixed, Composition: 6.8K ohms ±10%, 1/2W; Allen-Bradley EB	626 682 1	A
37	R24	Resistor, Fixed, Composition: 100 ohms ±10%, 1/2W; Allen-Bradley EB	626 101 1	A

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DATE 9 / 6 / 63

UNIT TITLE

REFERENCE AMPLIFIER

MODEL NO.

6.464- 4 Sh. 2 of 3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
38	R25,38	Resistor, Fixed, Composition: 2.2K ohms ±10%, 1/2W; Allen-Bradley EB	626 222 1	A
39	R27	Resistor, Fixed, Composition: 33 ohms ±10%, 1/2W; Allen-Bradley EB	626 330 1	A
40	R30,34	Resistor, Fixed, Composition: 10K ohms ±10%, 1/2W; Allen-Bradley EB	626 103 1	A
41	R31,36	Resistor, Fixed, Composition: 220 ohms ±10%, 1/2W; Allen-Bradley EB	626 221 1	A
42	R32	Resistor, Fixed, Composition: 120K ohms ±10%, 1/2W; Allen-Bradley EB	626 124 1	A
43	R43	Resistor, Fixed, Film: 700 ohms ±1%, 1/2W; Weston 9852B Type	634 339 0	B
44	R44	Resistor, Fixed, Composition: 15K ohms ±10%, 1/2W; Allen-Bradley EB	626 153 1	A
45	R48	Resistor, Fixed, Composition: 1.8K ohms ±10%, 1/2W; Allen-Bradley EB	626 182 1	A
46	R49	Resistor, Fixed, Composition: 1.2K ohms ±10%, 1W; Allen-Bradley GB	627 122 1	A
47	R50	Resistor, Fixed, Film: 22,000 ohms ±1%, 1/2W; International Resistance Corp. DCC Type	634 296 0	B
48	R51	Resistor, Fixed, Composition: 220 ohms ±10%, 2W; Allen-Bradley HB	628 221 1	A
49	R52	Resistor, Fixed, Film: 8.2K ohms ±1%, 1/2W; International Resistance Corp. DCC Type	634 294 0	B
50	R53	Resistor, Fixed, Film: 15,000 ohms ±1%, 1/2W; International Resistance Corp. DCC Type	634 295 0	B
51	R54	Resistor, Variable, Wirewound: 20 ohms ±5%, 1W; Daystrom Pacific 300-00	B642 419 0	B
52	R200	Resistor, Fixed, Composition: 51 ohms ±5%, 1W; Allen-Bradley GB	627 510 0	A
53	Z1	Oven, Zener	6.210	C

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DATE 9 / 6 / 63

UNIT TITLE

REFERENCE AMPLIFIER

MODEL NO.

6.464-4 Sh. 3 of 3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	CR1-3,5-7, 9-11,13-15	Diode, Silicon: Diodes, Inc. DI-51	A614 109 0	B
2	CR4,8,12,16	Diode, Germanium: General Instrument E071	614 170 0	B

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DATE 8 / 26 / 63

UNIT TITLE

RECTIFIER NETWORK

MODEL NO.

12.675

Sh. 1 of 1 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1	Capacitor, Fixed, Electrolytic: 20 UF -10%, +100%, 25 VDCW; Sprague TE-1206	516 148 0	B
2	C2	Capacitor, Fixed, Electrolytic: 2 UF -15%, +100%, 25 VDCW; Sprague TE-1201	516 236 0	A
3	C3,4	Capacitor, Fixed, Ceramic: 3000 PF ±20%, 75 VDCW; Glenco MIN-K-3000-M	515 149 0	B
4	C5	Capacitor, Fixed, Ceramic: 4700 PF ±20%, 1000 VDCW; Cornell-Dubilier BYA10D47M	515 008 0	A
5	C6	Capacitor, Fixed, Ceramic: 1000 PF GMV, 600 VDCW; Cornell-Dubilier BYA6D1	515 005 0	A
6	C7	Capacitor, Fixed, Ceramic: 330 PF ±10%, 500 VDCW; Erie Resistor Corp. GP2K-330±33	515 044 0	A
7	C10	Capacitor, Fixed, Ceramic: .05 UF ±20%, 500 VDCW; Sprague 33C17A	515 144 0	B
8	CR4,5,8,9, 11,12,14, 15,16	Diode, Germanium: Clevite CTP462	614 043 0	B
9	CR6,10	Diode, Silicon: Continental Device Corp. CD1282	B614 117 0	B
10	CR7,13	Diode, Silicon: Zener; Motorola 1/4M17Z5	614 118 0	B
11	Q1-4	Transistor, Germanium: PNP; Industro	B686 032 0	C
12	R1	Resistor, Variable, Wirewound: 1000 ohms ±10% .25W; Bourns Laboratories 200P-1-102	642 317 0	B
13	R1p	Resistor, Padder: 250 ohms ±20 ohms; Kelvin Electric Co.	B638 628 0	C
14	R2,3	Resistor, Variable, Wirewound: 100 ohms ±10%, 1/4W; Bourns Laboratories 200P-1-101	642 314 0	B
15	R2p	Resistor, Padder: 300 ohms ±2 ohms; Kelvin Electric Co.	B638 628 0	C
16	R3p	Resistor, Padder: 200 ohms ±2 ohms; Kelvin Electric Co.	B638 628 0	C
17	R4	Resistor, Variable, Wirewound: 50 ohms ±10%, 1/4W; Bourns Laboratories 200P-1-500	642 313 0	B

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DATE 10 / 19 / 63

UNIT TITLE

MISCELLANEOUS NETWORK CARD

MODEL NO.

12.1064 Sh. 1 of 3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
18	R4p	Resistor, Padder: 80 ohms ±1 ohm; Kelvin Electric Co.	B638 628 0	C
19	R5	Resistor, Fixed, Composition: 100K ohms ±10%, 1/2W; Allen-Bradley EB	626 104 1	A
20	R6,22,23,28	Resistor, Fixed, Composition: 22K ohms ±10%, 1/2W; Allen-Bradley EB	626 223 1	A
21	R7,10	Resistor, Fixed, Composition: 3.3K ohms ±10%, 1/2W; Allen-Bradley EB	626 332 1	A
22	R8	Resistor, Fixed, Composition: 15K ohms ±10%, 1/2W; Allen-Bradley EB	626 153 1	A
23	R9	Resistor, Fixed, Composition: 68K ohms ±10%, 1/2W; Allen-Bradley EB	626 683 1	A
24	R11	Resistor, Fixed, Composition: 18K ohms ±10%, 1/2W; Allen-Bradley EB	626 183 1	A
25	R12,13	Resistor, Fixed, Composition: 10K ohms ±10%, 1/2W; Allen-Bradley EB	626 103 1	A
26	R14	Resistor, Variable, Wirewound: 10 ohms ±10%, 2W; Atohm Electronics 114-100	642 534 0	B
27	R14p	Resistor, Padder: 28 ohms; Kelvin Electric Co	B638 628 0	C
28	R15	Resistor, Fixed, Wirewound, Precision: 50,000 ohms ±0.05%, 0.25W; Julie Research Labs R34 Type	638 046 0	C
29	R16	Resistor, Variable, Wirewound: 20K ohms ±10%, 1/4W; Bourns Laboratories 200P-1-203	642 321 0	B
30	R17	Thermistor: 10K ohms ±10% at 25°C; General Electric 1D101	B646 031 0	B
31	R18	Resistor, Fixed, Composition: 56 ohms ±10%, 1/2W; Allen-Bradley EB	626 560 1	A
32	R19,21	Resistor, Fixed, Wirewound, Precision (Matched Pair): 2 ea. 10,000 ohms ±.05%; Julie Research Labs R34 Type	640 043 0	C
33	R20	Resistor, Variable, Wirewound: 20 ohms ±10%, 1/4W; Bourns Laboratories 200P-1-200	642 312 0	B
34	R24	Resistor, Fixed, Composition: 56K ohms ±10%, 1/2W; Allen-Bradley EB	626 563 1	A

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DATE 10 / 19 63

UNIT TITLE

MISCELLANEOUS NETWORK CARD

MODEL NO.

12.1064 Sh. 2 of 3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
35	R25,26	Resistor, Fixed, Composition: 1.8K ohms ±10%, 1/2W; Allen-Bradley EB	626 182 1	A
36	R29	Resistor, Fixed, Composition: 82K ohms ±10%, 1/2W; Allen-Bradley EB	626 823 1	A

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DATE 10 / 19 / 63

UNIT TITLE

MISCELLANEOUS NETWORK CARD

MODEL NO.

12.1064 Sh.3 of 3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1	Capacitor, Fixed, Plastic: 1 UF ±20%, 200V Hopkins 1P2M	521 056 0	B
2	C2	Capacitor, Fixed, Electrolytic: 20 UF, 150V Cornell-Dubilier BBR 20-150	516 177 0	A
3	R1	Resistor, Fixed, Wirewound, Precision: 8,964 ohms ±.05%, Julie Research Labs R34 Type	A638 317 0	C
4	R2	Resistor, Fixed, Wirewound, Precision: 100,000 ohms ±.05%; Julie Research Labs R34 Type	A638 316 0	C
5	R3	Resistor, Fixed, Film: 60,000 ohms ±1%, 1/2W; Weston 9852B	634 468 0	B

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DATE 4 / 13 / 63

UNIT TITLE

REFERENCE AMPLIFIER NETWORK

MODEL NO.

12.722 Sh. 1 of 1 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1-1,1-2, 2-1,2-2, 3-1,3-2,12, 14,20	Capacitor, Fixed, Ceramic: 1000 PF GMV, 600V; Cornell-Dubilier BYA6D1	515 005 0	A
2	C4-1,4-2	Capacitor, Fixed, Electrolytic: 3.3 UF ±10%, 35V; Sprague 150D335X9035B2	516 276 0	A
3	C11	Capacitor, Fixed, Ceramic: 100 PF ±10%, 1000V; Cornell-Dubilier L1OT1	515 019 0	A
4	C13	Capacitor, Fixed, Ceramic: .01 UF +60% -40%, 150V; Centralab DDM-103	515 151 0	A
5	C21	Capacitor, Fixed, Ceramic: 560 PF ±10%, 150V; Glenco HO-150-Z-560K	515 167 0	B
6	C22	Capacitor, Fixed, Ceramic: 3000 PF ±20%, 75V; Glenco MIN-K-3000M	515 149 0	B
7	C23,24	Capacitor, Fixed, Electrolytic: 6.8 UF ±10%, 35V; Sprague 150D685X9035B2	516 277 0	A
8	CR1-39	Diode, Germanium: Clevite CTP462	614 043 0	B
9	Q1-1,1-2, 2-1,2-2, 3-1,3-2, 4-1,4-2,5, 6,11-14	Transistor, Germanium: PNP; RCA 2N404 Type	686 048 0	A
10	Q7-10	Transistor, Germanium: PNP; Bendix 2N1008B Type	686 022 0	B
11	R1-1,1-2, R2-1,2-2, 22,24	Resistor, Fixed, Composition: 3.3K ohms ±10%, 1/2W; Allen-Bradley EB	626 332 1	A
12	R3-1,3-2, 4-1,4-2, 9-1,9-2, 43,44	Resistor, Fixed, Composition: 15K ohms ±10%, 1/2W; Allen-Bradley EB	626 153 1	A
13	R5-1,5-2, 6-1,6-2, 11-1,11-2, 45,46	Resistor, Fixed, Composition: 100K ohms ±10%, 1/2W; Allen-Bradley EB	626 104 1	A

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DATE 4 / 13 / 63

UNIT TITLE
AUTOMATIC RANGE SWITCHING CIRCUITS

MODEL NO.
14.156-1 Sh. 1 of 2 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
14	R7-1,7-2, 8-1,8-2	Resistor, Fixed, Composition: 4.7K ohms ±10% 1/2W; Allen-Bradley EB	626 472 1	A
15	R10-1,10-2	Resistor, Fixed, Composition: 22K ohms ±5%, 1/2W; Allen-Bradley EB	626 223 0	A
16	R21,53	Resistor, Fixed, Composition: 22K ohms ±10%, 1/2W; Allen-Bradley EB	626 223 1	A
17	R23,27,33-40,49,52	Resistor, Fixed, Composition: 10K ohms ±10%, 1/2W; Allen-Bradley EB	626 103 1	A
18	R25	Resistor, Fixed, Composition: 8.2K ohms ±10%, 1/2W; Allen-Bradley EB	626 822 1	A
19	R26	Resistor, Fixed, Composition: 47K ohms ±10%, 1/2W; Allen-Bradley EB	626 473 1	A
20	R28,29,30, 42,47,48, 50,54	Resistor, Fixed, Composition: 3.9K ohms ±10%, 1/2W; Allen-Bradley EB	626 392 1	A
21	R31	Resistor, Fixed, Composition: 1.2K ohms ±10%, 1/2W; Allen-Bradley EB	626 122 1	A
22	R32	Resistor, Fixed, Wirewound: 4.7 ohms ±10%, 1W International Resistance Co. BW-1 Type	636 118 0	A
23	R41	Resistor, Fixed, Composition: 2.7K ohms ±10%, 1/2W; Allen-Bradley EB	626 272 1	A
24	R51	Resistor, Fixed, Composition: 1.8K ohms ±10%, 1/2W; Allen-Bradley EB	626 182 1	A
25	R55	Resistor, Fixed, Composition: 12K ohms ±10%, 1/2W; Allen-Bradley EB	626 123 1	A

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DATE 4/13/63

UNIT TITLE
AUTOMATIC RANGE SWITCHING CIRCUITS

MODEL NO.
14.156-1 Sh. 2 of 2 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	CR3,5,7,9, 11 thru 35	Rectifier, Silicon: Hughes Semiconductor HD6226	614 034 0	B
2	CR4,6,8, 10,36	Diode, Silicon: Hughes Semiconductor 1N459	B614 007 0	B
3	HR1,2	Resistor, Heat Pad: Electro-Flex Heat Inc. 1388	646 022 0	B
4	R1	Resistor, Fixed, Film: 56K ohms ±1%, 1/4W; Aerovox CPX-1/4	634 432 0	A
5	R2	Resistor, Fixed, Film: 10K ohms ±1%, 1/4W; Aerovox CPX-1/4	634 431 0	A
6	S1	Switch, Thermostat: Fenwall 32,410-1	B662 018 0	B
		COMPARATOR AMPLIFIER 26.134-3		
1	C1	Capacitor, Fixed, Ceramic: 560 PF ±10%, 500V; Erie Resistor Corp. GP2K-560 ±56	515 047 0	A
2	CR1,3,4,	Diode, Germanium: Clevite CTP462	614 043 0	B
3	CR2,5	Diode, Silicon: Hughes Semiconductor 1N459	B614 007 0	B
4	Q1,2	Transistor, Germanium: PNP; Sprague 2N345	686 006 0	B
5	Q3,4,5	Transistor, Germanium: PNP; RCA 2N404	686 048 0	A
6	R1	Resistor, Fixed, Film: 190K ohms ±1%, 1/4W; Aerovox CPX-1/4	634 433 0	A
7	R2,4	Resistor, Fixed, Composition: 1.8K ohms ±10%, 1/2W; Allen-Bradley EB	626 182 1	A
8	R3	Resistor, Fixed, Composition: 220 ohms ±10%, 1/2W; Allen-Bradley EB	626 221 1	A
9	R5	Resistor, Fixed, Composition: 1.5K ohms ±10%, 1/2W; Allen-Bradley EB	626 152 1	A
10	R6,7,8	Resistor, Fixed, Composition: 3.3K ohms ±10%, 1/2W; Allen-Bradley EB	626 332 1	A
11	R9,10	Resistor, Fixed, Composition: 10K ohms ±10%, 1/2W; Allen-Bradley EB	626 103 1	A
12	R11	Resistor, Fixed, Composition: 100 ohms ±5%, 1/2W; Allen-Bradley EB	626 101 0	A

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DATE 9 / 6 / 63

UNIT TITLE
COMPARATOR AND DIODE GATE

MODEL NO.
26.096-4

Sh. 1 of 1 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	R1	Resistor, Fixed, Wirewound, Precision: 1,249,685 Ohms ± .1%	A638 460 0	C
2	R2	Resistor, Fixed, Film: 12.5 Megohms ± 1%, 2W; Aerovox CPX-2	634 225 0	A
3	R3	Resistor, Fixed, Film: 2.5 Megohms ± 1%, 1/2W; Aerovox CPX-1/2	634 187 0	A
4	R4	Resistor, Fixed, Film: 25 Megohms ± 1%, 2W; Aerovox CPX-2	634 189 0	A
5	R5	Resistor, Fixed, Film: 5 Megohms ± 1%,, 1/2W; Aerovox CPX-1/2	634 034 0	A
6	R6	Resistor, Fixed, Film: 50 Megohms ± 1%, 2W; Aerovox CPX-2	634 190 0	A
7	R7	Resistor, Fixed, Film: 10 Megohms ± 1%, 1W; Aerovox CPX-1	634 053 0	A
8	R8	Resistor, Fixed, Film: 100 Megohms ± 2%, 2W; Aerovox CPX-2	634 191 0	A
9	R9	Resistor, Fixed, Wirewound, Precision: 12,442 Ohms ± .05%	A638 452 0	C
10	R9p	Resistor, Variable, Wirewound: 50 Ohms ± 5%, 1W; Daystrom-Pacific Model 301-60	B642 435 0	B
11	R10	Resistor, Fixed, Wirewound, Precision: 124,586 Ohms ± .05%	A638 456 0	C
12	R10p,15p	Resistor, Variable, Wirewound: 500 Ohms ± 5%, 1W; Daystrom-Pacific Model 301-60	B642 438 0	B
13	R11	Resistor, Fixed, Wirewound, Precision: 24,896 Ohms ± .05%	B638 453 0	C
14	R11p	Resistor, Variable, Wirewound: 100 Ohms ± 5%, 1W; Daystrom-Pacific Model 301-60	B642 436 0	B
15	R12	Resistor, Fixed, Wirewound, Precision: 249,749 Ohms ± .05%	A638 457 0	C
16	R13	Resistor, Fixed, Wirewound, Precision: 49,811 Ohms ± .05%	A638 454 0	C
17	R13p	Resistor, Variable, Wirewound: 200 Ohms ± 5%, 1W; Daystrom-Pacific Model 301-60	A642 437 0	B

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UNIT TITLE
SUMMING RESISTOR NETWORK

MODEL NO.
26.116-1 Sht. 1 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
18	R14	Resistor, Fixed, Wirewound, Precision: 499,648 Ohms ± .05%	A638 458 0	C
19	R15	Resistor, Fixed, Wirewound, Precision: 99,609 Ohms ± .05%	A638 455 0	C
20	R16	Resistor, Fixed, Wirewound, Precision: 999,598 Ohms ± .05%	A638 459 0	C
21	R17,18	Resistor, Fixed, Wirewound, Precision(Matched Pair): Total Series Resistance to be 1,253 Ohms ± .05%	A640 071 0	C
22	R19	Resistor, Fixed, Composition: 12 Megohms ± 10%, 1/2W' Allen-Bradley EB	626 126 1	A

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UNIT TITLE
SUMMING RESISTOR NETWORK

MODEL NO.
26.116-1 Sht. 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1,6,9,12	Capacitor, Fixed, Electrolytic: 55 UF +20%, -15%, 50V; Sprague 109D55C2050T2	516 237 0	A
2	C2,7,10	Capacitor, Fixed, Electrolytic: 10 UF +100% -15%, 15V; Sprague TE-1155	516 238 0	A
3	C3,8,11	Capacitor, Fixed, Electrolytic: 50 UF +100% -15%, 25V; Sprague TE-1209	516 149 0	A
4	C4,13	Capacitor, Fixed, Electrolytic: 30 UF +100% -15%, Sprague TE-1158	516 039 0	A
5	C5	Capacitor, Fixed, Electrolytic: 110 UF +100% -15%, 3V; Sprague TE-1060	516 043 0	A
6	CR1,3,4	Diode, Silicon: Zener; Texas Instruments 1N754A Type	614 046 1	B
7	CR2,5	Diode, Silicon: Zener; Texas Instruments 1N759A Type	B614 091 1	B
8	CR6	Diode, Silicon: Zener; Dickson Electronics DZ30307A	614 169 0	B
9	Q1,6,8	Transistor, Germanium: PNP; Motorola 2N652	686 084 0	B
10	Q2,7,9	Transistor, Germanium: PNP; RCA 2N404 Type	686 048 0	A
11	Q3,4,5	Transistor, Germanium: PNP; General Electric 2N321 Type	686 004 0	A
12	R1,2,13,14, 20,21	Resistor, Fixed, Composition: 4.7K ohms ±10% 1/2W; Allen-Bradley EB	626 472 1	A
13	R3,15,22	Resistor, Fixed, Composition: 8.2K ohms ±10% 1/2W; Allen-Bradley EB	626 822 1	A
14	R4,16,23,28, 29,30	Resistor, Fixed, Composition: 1K ohms ±10%, 1/2W; Allen-Bradley EB	626 102 1	A
15	R6,18,25	Resistor, Variable, Wirewound: 200 ohms ±10%, 1W; Bourns Laboratories 260P-1-201	642 327 0	B
16	R7,19,26	Resistor, Fixed, Composition: 560 ohms ±10%, 1/2W; Allen-Bradley EB	626 561 1	A
17	R8	Resistor, Fixed, Composition: 680 ohms ±5%, 1/2W; Allen-Bradley EB	626 681 0	A

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DATE 8 / 26 / 63

UNIT TITLE

POWER SUPPLY REGULATOR

MODEL NO.

43.126-1 Sh.1 of 2 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
18	R9	Resistor, Fixed, Composition: 300 ohms ±5%, 1/2W; Allen-Bradley EB	626 301 0	A
19	R11	Resistor, Fixed, Composition: 1.1K ohms ±5%, 1/2W; Allen-Bradley EB	626 112 0	A
20	R12	Resistor, Fixed, Composition: 200 ohms ±5%, 1/2W; Allen-Bradley EB	626 201 0	A
21	R27	Resistor, Fixed, Composition: 2K ohms ±10%, 1/2W; Allen-Bradley EB	626 202 1	A
22	R31	Resistor, Fixed, Composition: 100 ohms ±10%, 1W; Allen-Bradley HB	627 101 1	A

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DATE 8/ 26 / 63

UNIT TITLE

POWER SUPPLY REGULATOR

MODEL NO.

43.126 -1 Sh. 2 of 2 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1,4,5 Thru 22	Capacitor, Fixed, Ceramic: 1000 UUF ± 10%, 75V; Glenco Min-Z-1000-K	515 145 0	B
2	C2,3	Capacitor, Fixed, Ceramic: 3000 UUF ± 20%, 75V; Glenco Min-K-3000-M	515 149 0	B
3	CR1 Thru 21	Diode, Germanium: Clevite CTP462	614 043 0	B
4	Q1 Thru 12	Transistor, Germanium: PNP; Industro	B686 032 0	B
5	R1,2	Resistor, Fixed, Composition: 4.7K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 472 1	A
6	R3,9,12,17, 19,23,26, 31,35,39,43	Resistor, Fixed, Composition: 15K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 153 1	A
7	R4,10,13,18, 20,24,27,32, 40,44	Resistor, Fixed, Composition: 100K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 104 1	A
8	R5,8,11,14, 25,33,37,38, 47 Thru 52	Resistor, Fixed, Composition: 10K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 103 1	A
9	R6,7,15,16, 21,22,29,30, 41,42	Resistor, Fixed, Composition: 3.3K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 332 1	A
10	R34,36,45	Resistor, Fixed, Composition: 22K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 223 1	A

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UNIT TITLE
BINARY CODED DECADE COUNTER

MODEL NO.
44.139

Sh. 1 of 1 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1,4,5 Thru 22	Capacitor, Fixed, Ceramic: 1000 UUF ± 10%, 75V; Glenco Min-Z-1000-K	515 145 0	B
2	C2,3	Capacitor, Fixed, Ceramic: 3000 UUF ± 20%, 75V; Glenco Min-K-3000-M	515 149 0	B
3	CR1-17,19-21,201	Diode, Germanium: Clevite CTP462	614 043 0	B
4	Q1 Thru 12	Transistor, Germanium: PNP;(2N324 Type Mod.)	B686 032 0	C
5	R1,2	Resistor, Fixed, Composition: 4.7K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 472 1	A
6	R3,9,12,17, 19,23,26, 31,35,39,43	Resistor, Fixed, Composition: 15K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 153 1	A
7	R4,10,13,18, 20,24,27,32, 40,44	Resistor, Fixed, Composition: 100K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 104 1	A
8	R5,8,11,14, 25,33,37,38, 47 Thru 52	Resistor, Fixed, Composition: 10K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 103 1	A
9	R6,7,15,16, 21,22,29,30, 41,42	Resistor, Fixed, Composition: 3.3K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 332 1	A
10	R34,36,45	Resistor, Fixed, Composition: 22K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 223 1	A

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UNIT TITLE
BINARY CODED DECADE COUNTER

MODEL NO.
44.139-4 Sh. 1 of 1 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1	Capacitor, Fixed, Ceramic: 220 UUF ± 10%, 600V; Cornell-Dubilier LA-S3	515 020 0	B
2	C2,4 Thru 11, 13 Thru 16	Capacitor, Fixed, Ceramic: 1000 UUF ± 10%, 75V; Glenco Min-Z-1000-K	515 145 0	B
3	C3	Capacitor, Fixed, Ceramic: 5600 UUF GMV, 600V; Centralab D6-562	515 179 0	B
4	C12	Capacitor, Fixed, Ceramic: .47 UF ± 20%, 25V; Sprague 5C11	515 190 0	B
5	CR1 Thru 11 13,14,300	Diode, Germanium: Clevite CTP462	614 043 0	B
6	L1	Coil: 3.3 MH ± 10%; Essex WEE-3300	538 009 0	C
7	Q1 Thru Q14	Transistor, Germanium: PNP;(2N324 Type Mod.)	B 686 032 0	C
8	R1,5,16,17, 18,29,42, 43,52	Resistor, Fixed, Composition: 10K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 103 1	A
9	R2	Resistor, Fixed, Composition: 1.5K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 152 1	A
10	R3,7,36	Resistor, Fixed, Composition: 470 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 471 1	A
11	R4,34,38	Resistor, Fixed, Composition: 1K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 102 1	A
12	R6	Resistor, Fixed, Composition: 270K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 274 1	A
13	R9,10,14, 19,23,27, 32,46,47, 50,53	Resistor, Fixed, Composition: 15K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 153 1	A
14	R11,15,20, 24,25,28, 33,39,48,49	Resistor, Fixed, Composition: 100K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 104 1	A
15	R12,13	Resistor, Fixed, Composition: 820 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 821 1	A
16	R21,22,30, 31,44,45	Resistor, Fixed, Composition: 3.3K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 332 1	A

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UNIT TITLE
PROGRAMMER

MODEL NO.
44.170-4 Sht. 1 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
17	R26	Resistor, Fixed, Composition: 22K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 223 1	A
18	R51	Resistor, Fixed, Composition: 470K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 474 1	A
19	T1	Transformer, Pulse: Technitrol CB1JA (395.7)	A684 091 0	C

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UNIT TITLE
PROGRAMMER

MODEL NO.
44.170-4 Sht. 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	CR1 Thru CR38	Diode, Germanium: Clevite CTP462	614 043 0	B
2	Q1 Thru Q10	Transistor, Germanium: PNP; 2N321 Type	686 004 0	A
3	Q11 Thru Q18	Transistor, Germanium: PNP ; (2N324 Type Modified)	B686 032 0	C
4	R1 Thru R10	Resistor, Fixed, Composition: 1.2K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 122 1	A
5	R11,17,19, 25,26,33, 34,41	Resistor, Fixed, Composition: 22K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 223 1	A
6	R13,16,21, 24,29,32, 37,40	Resistor, Fixed, Composition: 3.3K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 332 1	A
7	R12,14,15, 18,20,22, 23,27,28, 30,31,35, 36,38,39, 42	Resistor, Fixed, Composition: 10K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 103 1	A
8	R43	Resistor, Fixed, Wirewound: 4.7 Ohms ± 10%, 1/2W; International Resistance Co. Type BW 1/2	636 172 0	B

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UNIT TITLE
READOUT STORAGE DECADE

MODEL NO
51.01C

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	CR1-56,59-62	Diode, Germanium: Clevite CTP 462 Type	614 043 0	B
2	Q1-10	Transistor, Germanium: PNP; Industro	B686 032 0	C
3	Q11-22	Transistor, Germanium: PNP; General Electric 2N321 Type	686 004 0	A
4	R1,2,9,10, 17,18,25, 26,40,52, 53	Resistor, Fixed, Composition: 3.3K ohms ±10% 1/2W; Allen-Bradley EB	626 332 1	A
5	R3-6, 11-14, 19-22, 27-30,54	Resistor, Fixed, Composition: 10K ohms ±10% 1/2W; Allen-Bradley EB	626 103 1	A
6	R7,8,15,16, 23,24,31, 32	Resistor, Fixed, Composition: 22K ohms ±10% 1/2W; Allen-Bradley EB	626 223 1	A
7	R33-39,41-48,56	Resistor, Fixed, Composition: 1.2K ohms ±10% 1/2W; Allen-Bradley EB	626 122 1	A
8	R49	Resistor, Fixed, Composition: 2.7K ohms ±10% 1W; Allen-Bradley GB	627 279 1	A
9	R50,51,55	Resistor, Fixed, Composition: 5.6K ohms ±10% 1/2W; Allen-Bradley EB	626 562 1	A

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DATE 7/ 1 / 62

UNIT TITLE

READOUT STORAGE DECADE

MODEL NO.

51.080-5 Sh. 1 of 1 Sh.

APPENDIX II

DRAWINGS

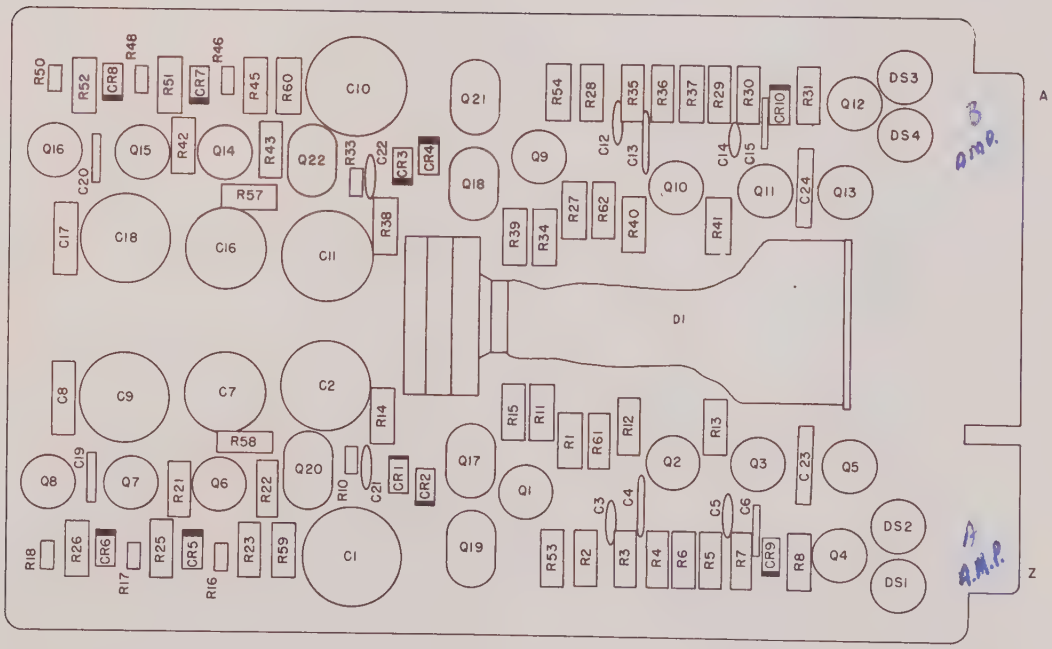
5001 TRANSISTORIZED DIGITAL VOLTMETER

This appendix contains necessary schematics and wiring diagrams of equipment described in this manual. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawings, and the associated drawing number. The drawings are bound into the manual in the order listed under the index Drawing Number column.

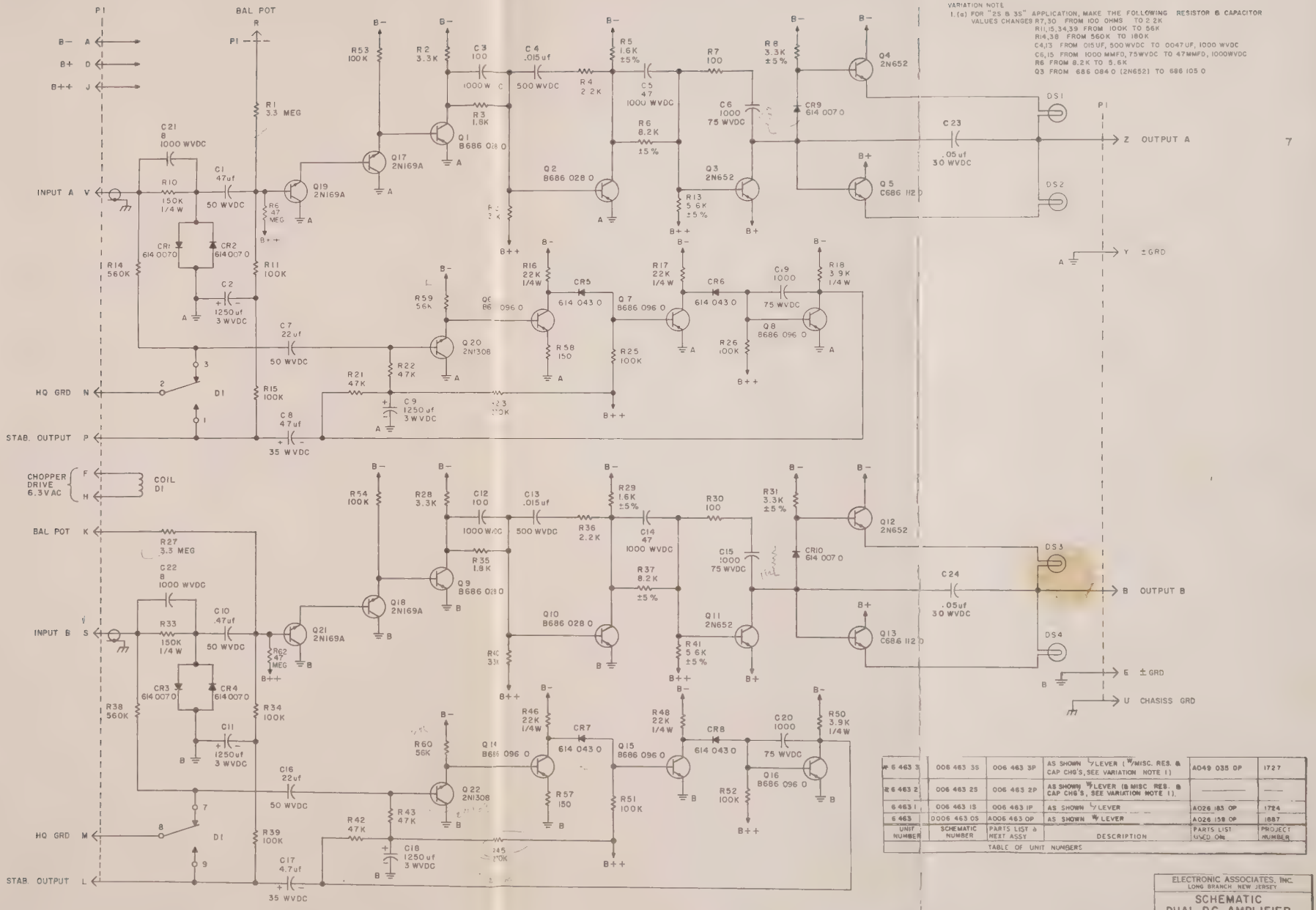
EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards.

INDEX

Unit or Component	Type of Drawing	Drawing Number
6.643-1 Dual DC Amplifier	Schematic	D006 463 0S
6.464-4 Reference Amplifier	Schematic	D006 464 0S (Sheet 2 only)
12.1022 Astable Network	Schematic	B012 1022 0S
12.1064 Network Card	Schematic	C012 1064 0S
14.156-1 Automatic Range Switching Circuits	Schematic	D014 156 0S
26.096-4 Comparator Amplifier and Diode Gate	Schematic	C026 096 0S
26.116-1 Summing Resistor Network	Schematic	C026 116 0S
26.134-3 Comparator Amplifier	Schematic	C026 134 0S (Sheet 2 only)
Model 26.158, 5001 TDVM	Schematic	D026 158 0S (Sheets 1 through 4)
	Wiring	D026 158 0W (Sheets 2 through 33)
43.126-1 Power Supply Regulator	Schematic	C043 126 0S
44.139 and 44.139-4 Binary Coded Decade Counter	Schematic	D044 139 0S
44.170-4 Programmer	Schematic	D044 170 0S
51.010 Readout Storage Decade	Schematic	D051 010 0S (Sheet 1 only)
51.080-5 Readout Storage Decade	Schematic	D051 080 0S (Sheet 2 only)



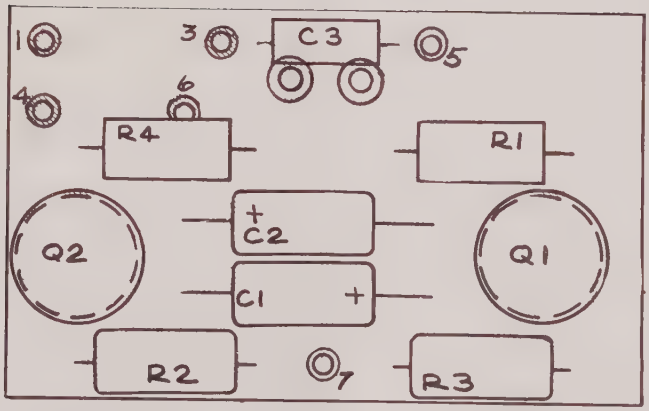
6.463-1 Dual DC Amplifier, Component Location Diagram



UNIT NUMBER	SCHEMATIC NUMBER	PARTS LIST & NEXT ASSY	DESCRIPTION	PARTS LIST USED ON	PROJECT NUMBER
# 6 463 3	006 463 3S	006 463 3P	AS SHOWN 1/LEVER (W/MISC. RES. & CAP CHG'S, SEE VARIATION NOTE 1)	A049 035 0P	1727
# 6 463 2	006 463 2S	006 463 2P	AS SHOWN W/LEVER (& MISC RES. & CAP CHG'S, SEE VARIATION NOTE 1).	———	———
6 463 1	006 463 1S	006 463 1P	AS SHOWN 1/LEVER	A026 183 0P	1724
6 463	D006 463 0S	A006 463 0P	AS SHOWN W/LEVER	A026 158 0P	1887

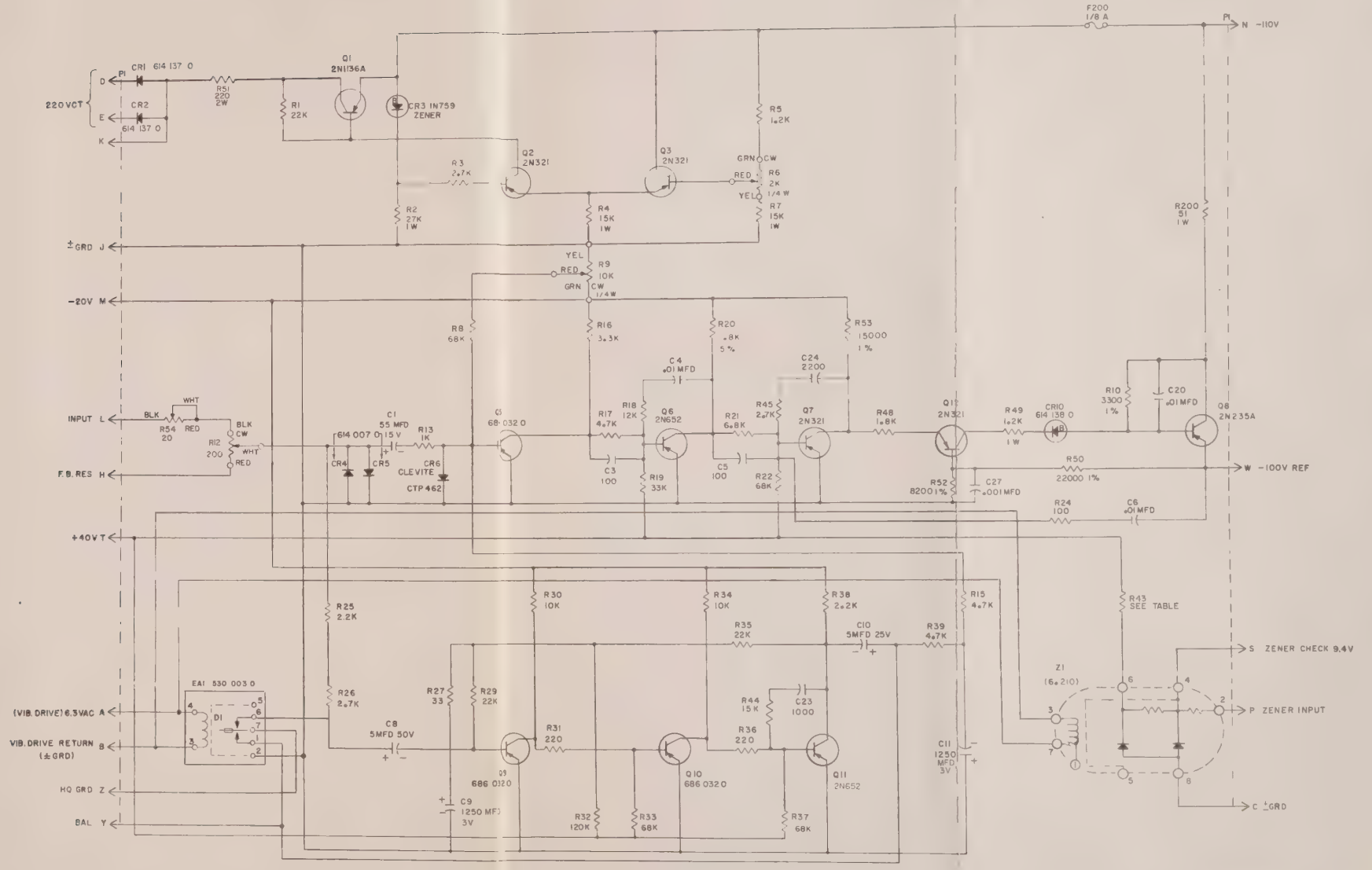
TABLE OF UNIT NUMBERS

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY
SCHEMATIC
DUAL D.C. AMPLIFIER
(SERIES 5001 TDVM)
SHT NO
SIZE
REV NO
PROJECT 1887 D006 463 0S
SHEET 1 OF SHEETS

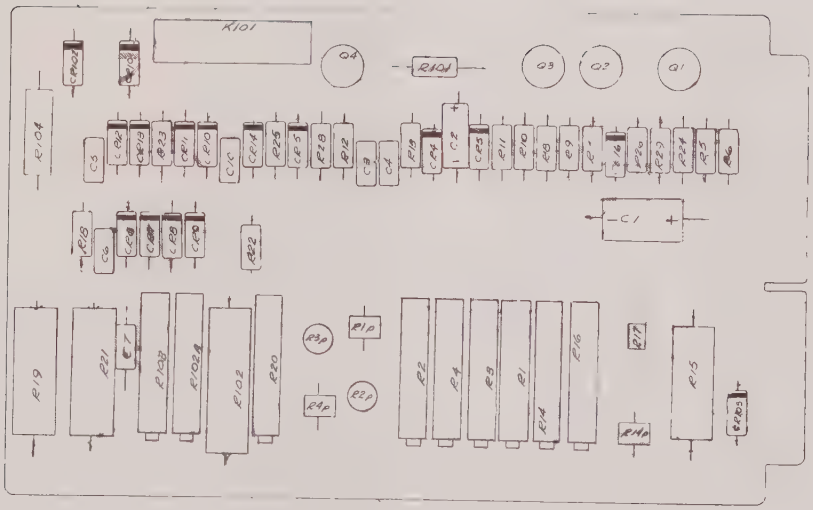


12.1022 Astable Network, Component Location Diagram

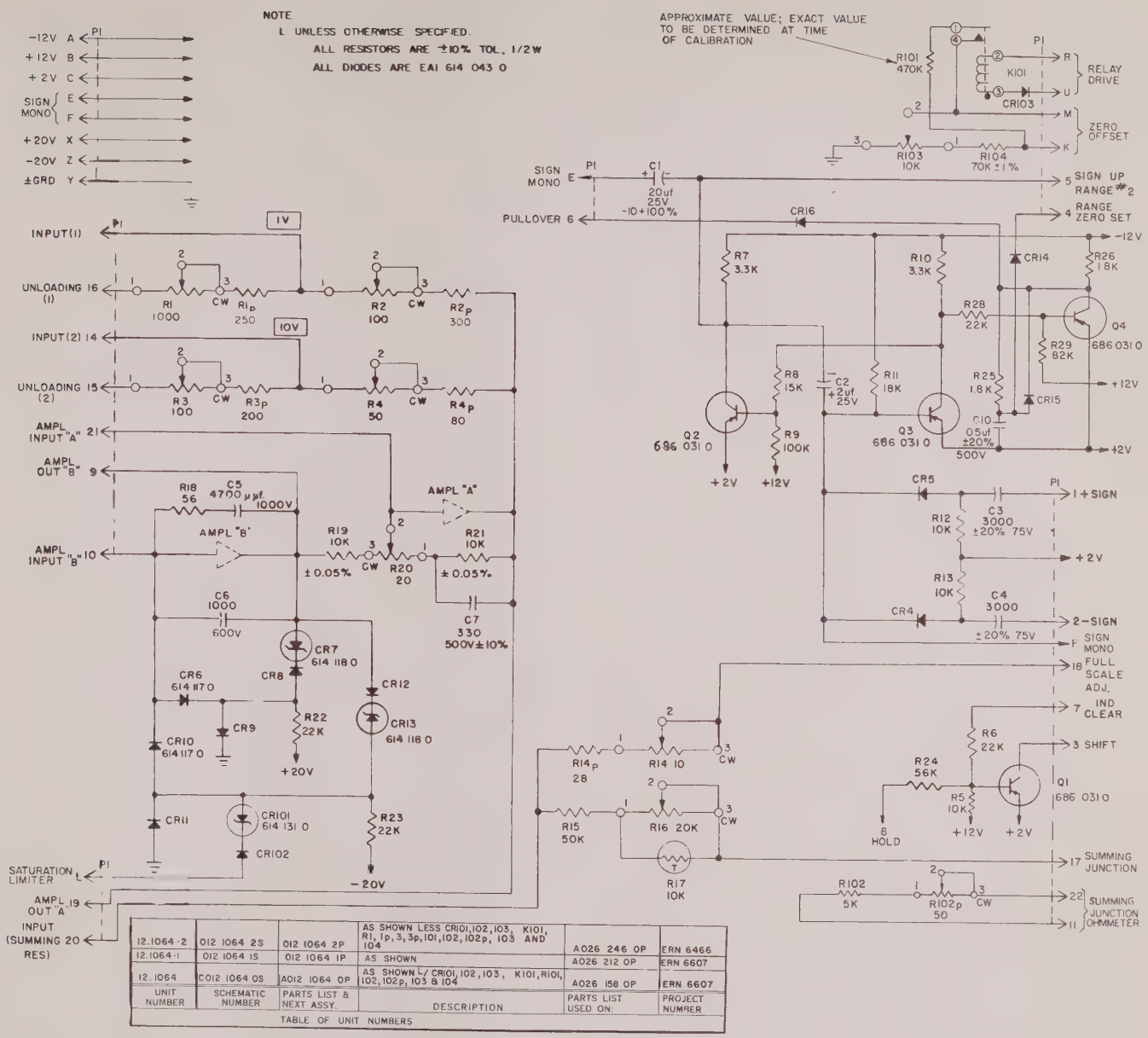
NOTE
1 ALL RESISTORS ARE 1/2 W ±10% UNLESS OTHERWISE SPECIFIED



ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY
SCHEMATIC
REFERENCE AMPLIFIER
(SERIES 5001 TDVM)
SHT NO
SIZE
REV NO
PROJECT 1887 D006 464 05
SHEET OF SHEETS



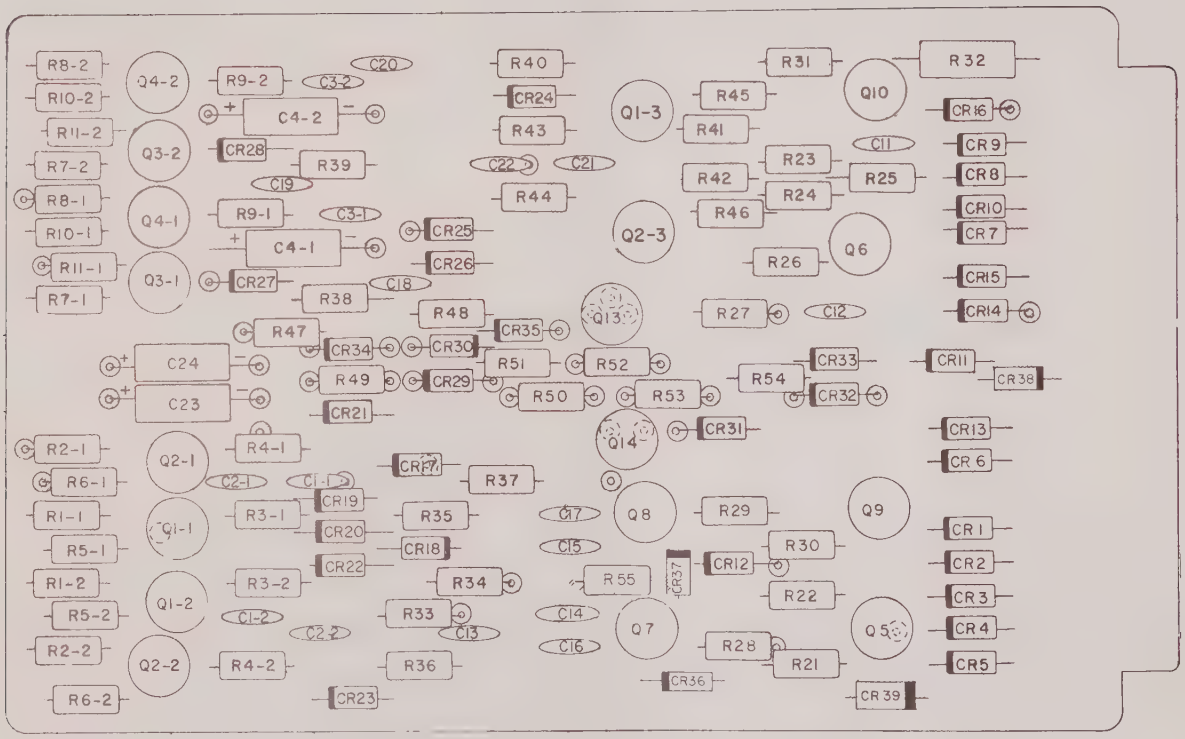
12.1064 Miscellaneous Network, Component Location Diagram



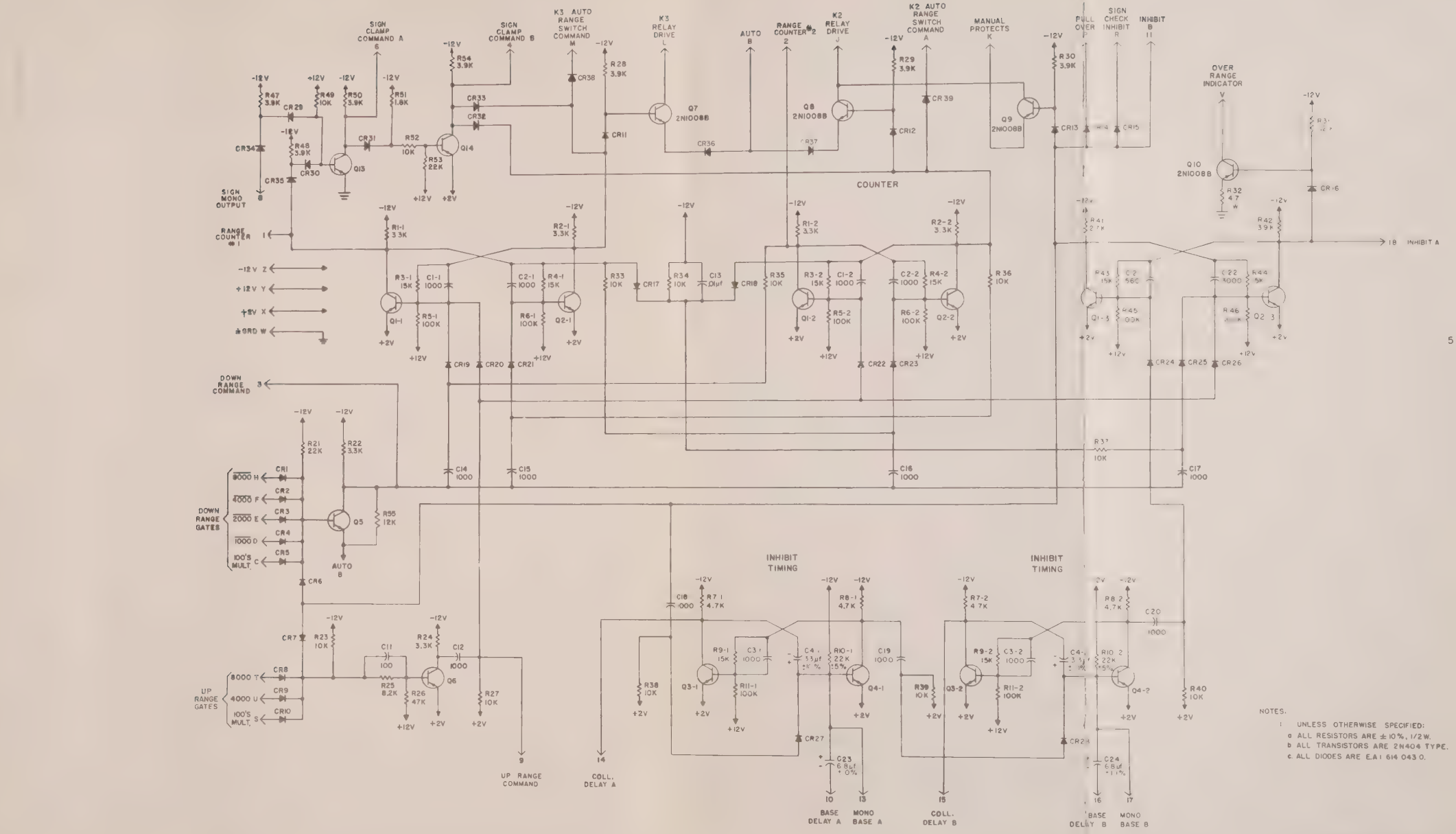
UNIT NUMBER	SCHEMATIC NUMBER	PARTS LIST & NEXT ASSY.	DESCRIPTION	PARTS LIST USED ON:	PROJECT NUMBER
12.1064-2	012 1064 2S	012 1064 2P	AS SHOWN LESS CR101,102,103, K101, R1, 1p, 3, 3p, 101, 102, 102p, 103 AND 104	A026 246 0P	ERN 6466
12.1064-1	012 1064 1S	012 1064 1P	AS SHOWN	A026 212 0P	ERN 6607
12.1064	C012 1064 0S	A012 1064 0P	AS SHOWN L/ CR101, 102, 103, K101, R101, 102, 102p, 103 & 104	A026 158 0P	ERN 6607

TABLE OF UNIT NUMBERS

ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
SCHEMATIC MISC. NETWORK CARD (SERIES 5001 TDVOM)	
SHT NO	
SIZE	
REV NO	
PROJECT ERN 6607	C012 1064 0S
SHEET / OF / SHEETS	



14.156-1 Auto Range Switching Circuit, Component Location Diagram



NOTES.

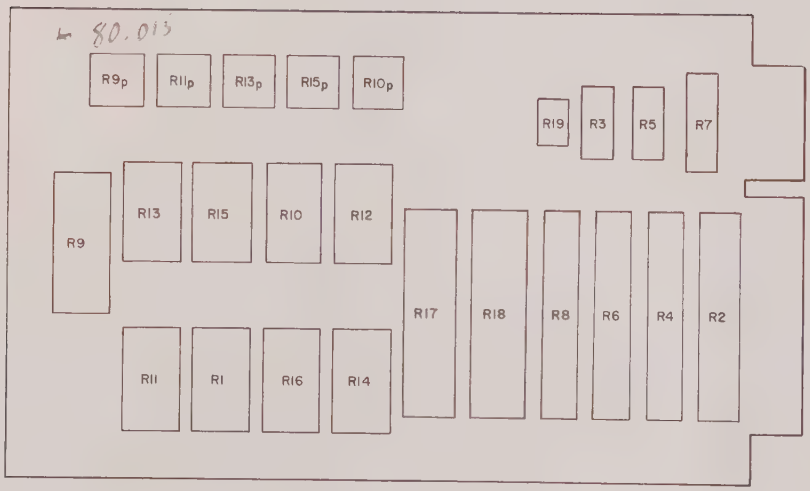
1. UNLESS OTHERWISE SPECIFIED:
   a. ALL RESISTORS ARE ± 10%, 1/2W.
   b. ALL TRANSISTORS ARE 2N404 TYPE.
   c. ALL DIODES ARE E.A.I 614 043 0.

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

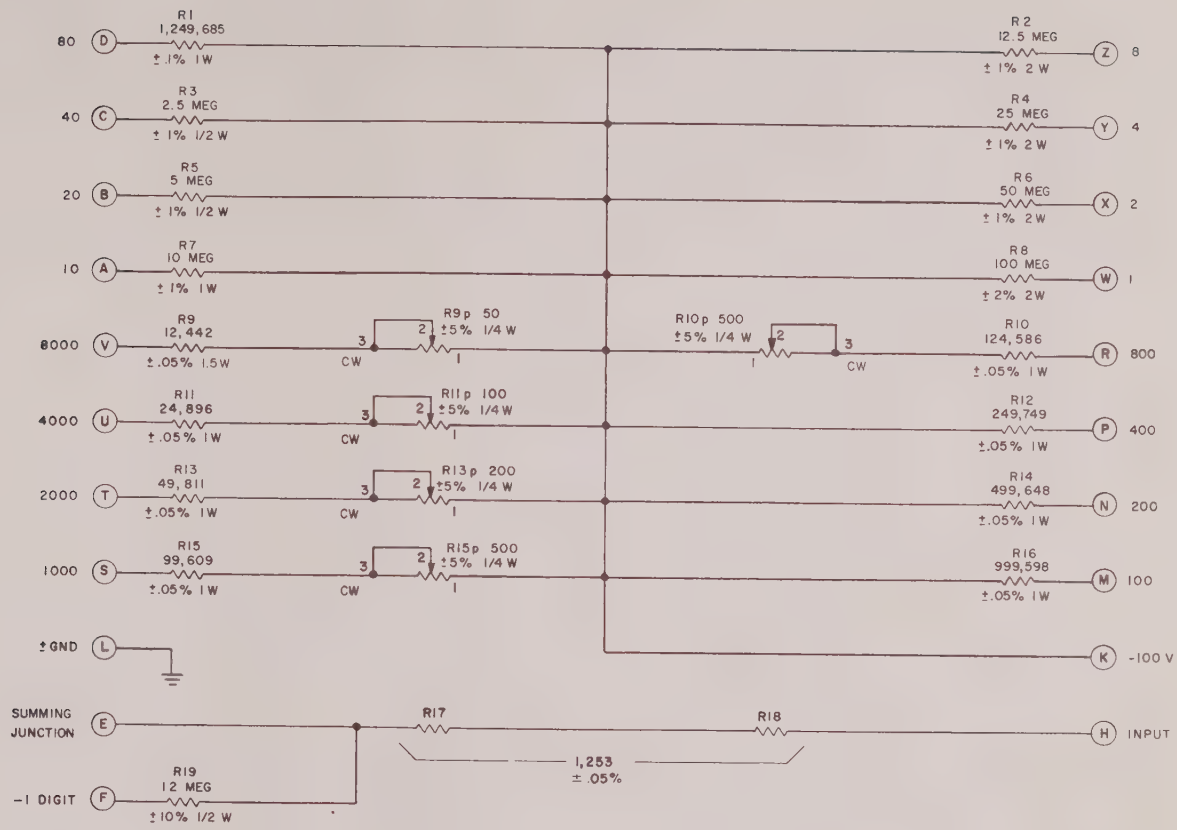
SCHEMATIC
AUTO. RANGE SW. CKT.
(SERIES 5001 TDVM)

PROJECT 1778 D014 156 05

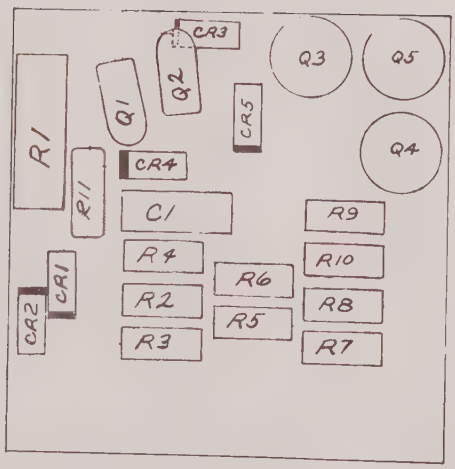
5



26.116-1 Summing Resistor Network, Component Location Diagram

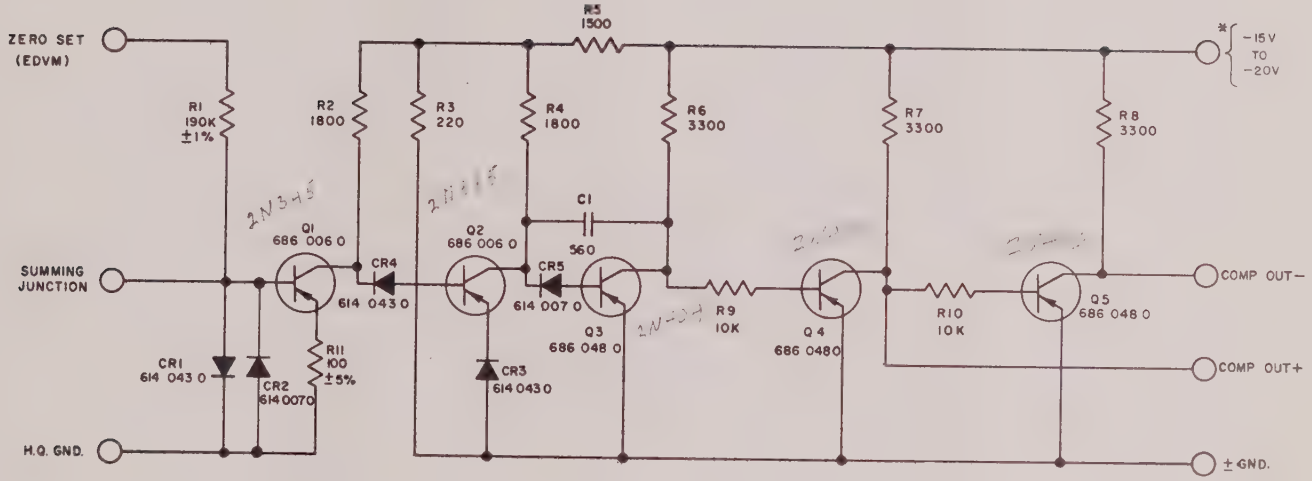


ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
SCHEMATIC SUMMING RESISTOR NETWORK	
SHT NO	
SIZE	
REV NO	
PROJECT 1877	C026 116 0S
SHEET 1 OF SHEETS	



26.134-3 Comparator Amplifier, Component Location Diagram

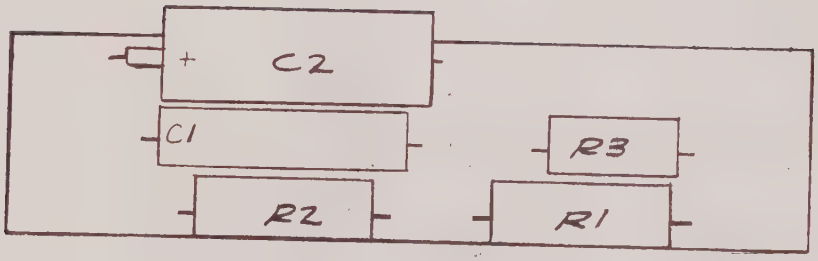
NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE ±10% TOLERANCE, 1/2 W.
2. ON THE TERMINAL DESIGNATED BY (*) THE VOLTAGE APPLIED DEPENDS ON THE EXTERNAL POWER SUPPLY USED.

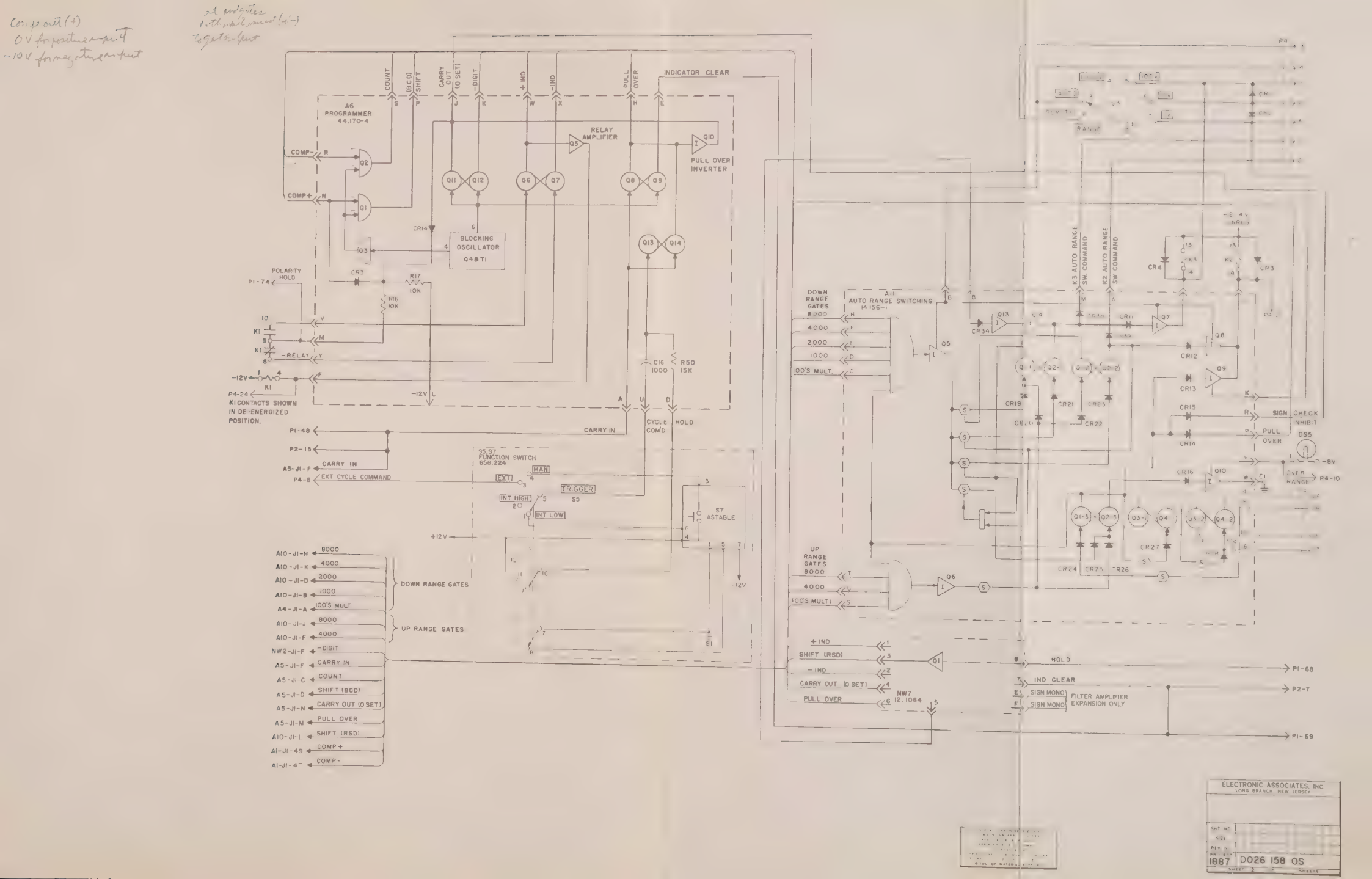


26.134 3S

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
CAPACITANCE IS IN MMFD
RESISTANCE IS IN OHMS
TOLERANCE ON
FRACTIONS ±1/64 · DECIMALS ± .005 · ANGLES ± 2
◇ TOL. OF MATERIAL SUPPLIED

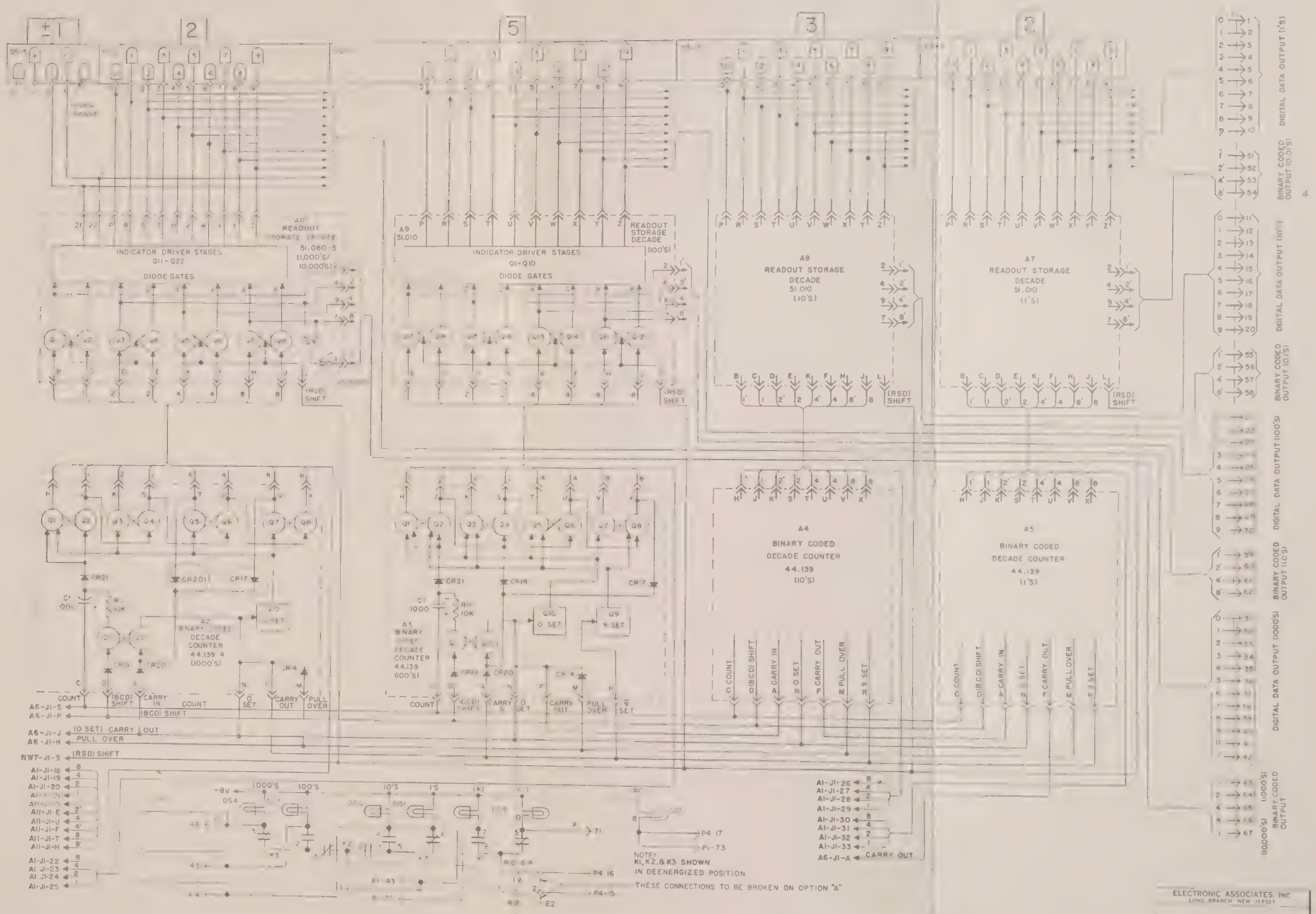
ELECTRONIC ASSOCIATES, INC LONG BRANCH NEW JERSEY	
SCHEMATIC DIAGRAM COMPARATOR AMPLIFIER	
SHT. NO.	
SIZE	
REV NO.	
PROJECT 1969	C026 134 0S
SHEET 2 OF 4 SHEETS	


+
C2
C1
R3
R2
R1



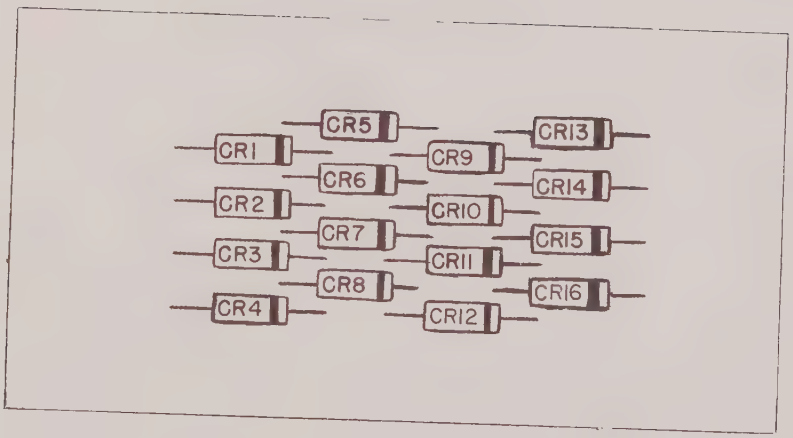
ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

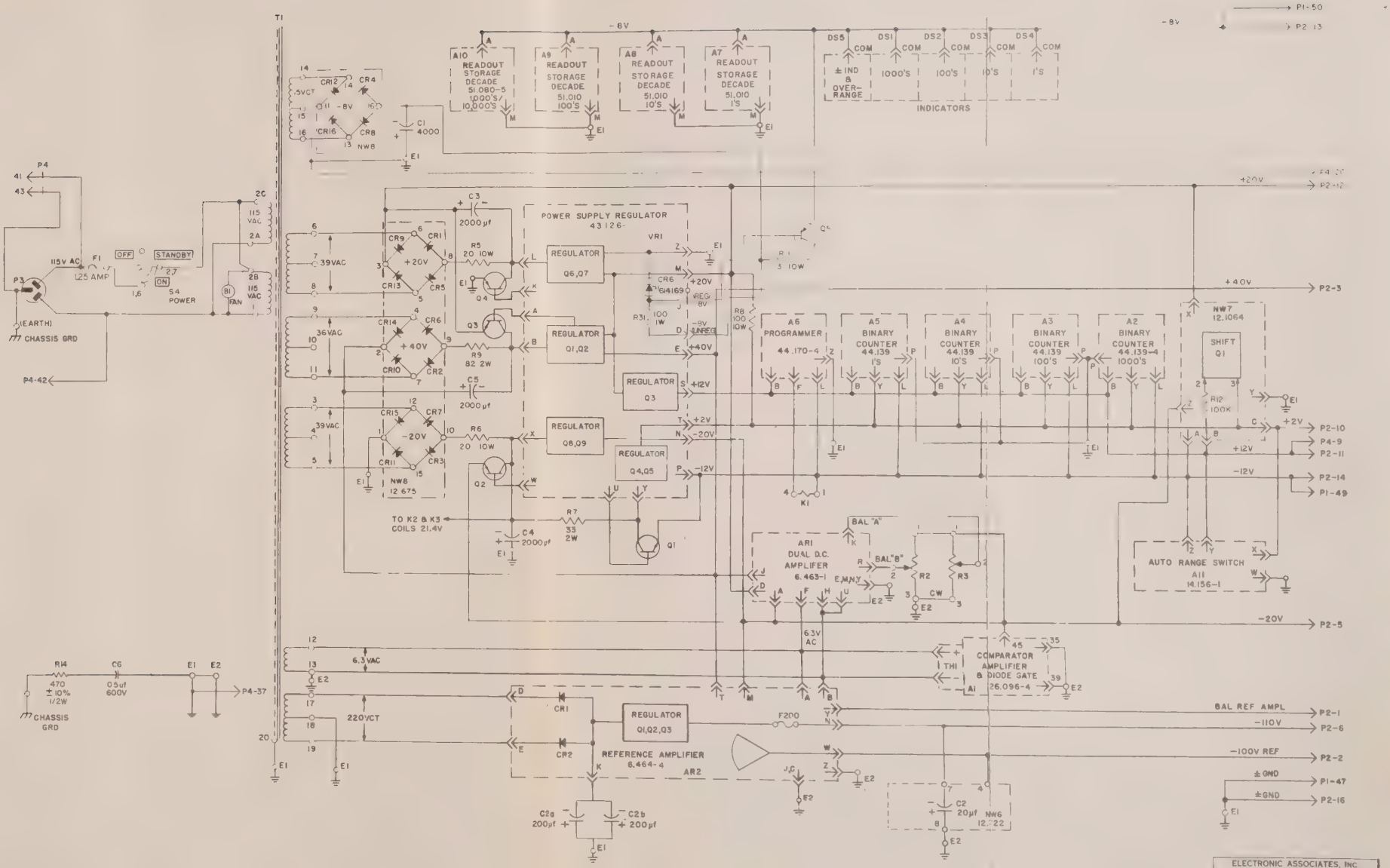
SHT NO
SIZE
REV NO
1887 D026 158 OS
SHEET SHEETS

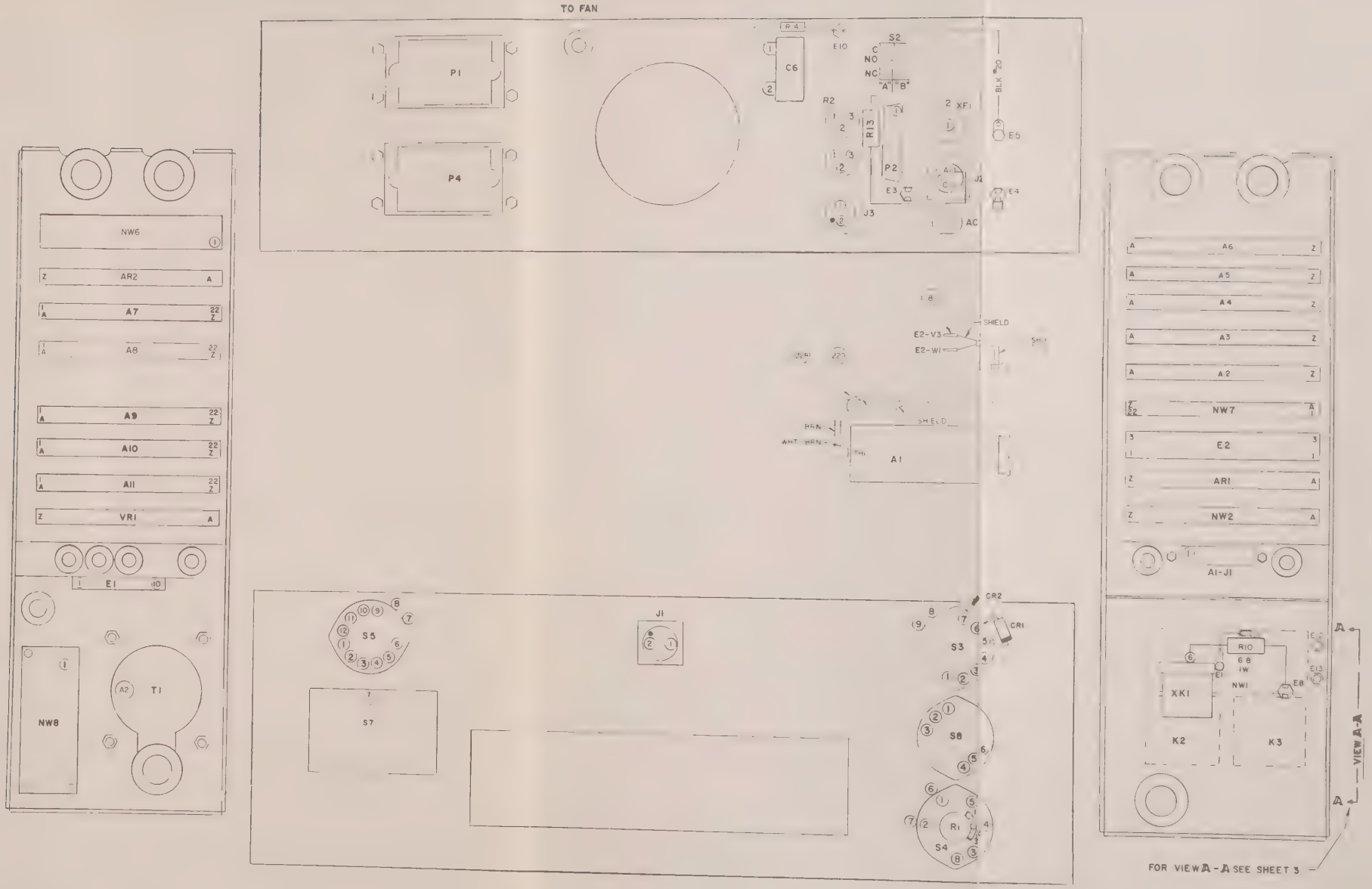


ELECTRONIC ASSOCIATES, INC
LONG BRANCH, NEW JERSEY

PROJECT 1087 D026 158 05

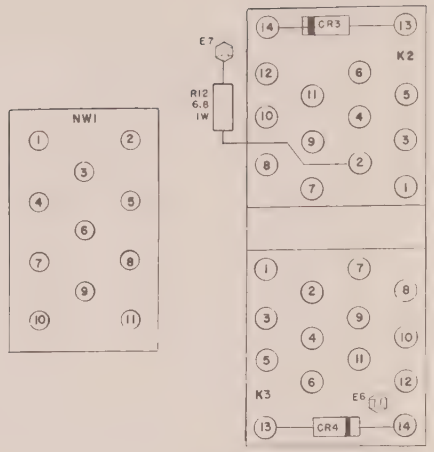

CR5
CR13
CR1
CR9
CR6
CR14
CR2
CR10
CR7
CR15
CR3
CR11
CR8
CR16
CR4
CR12

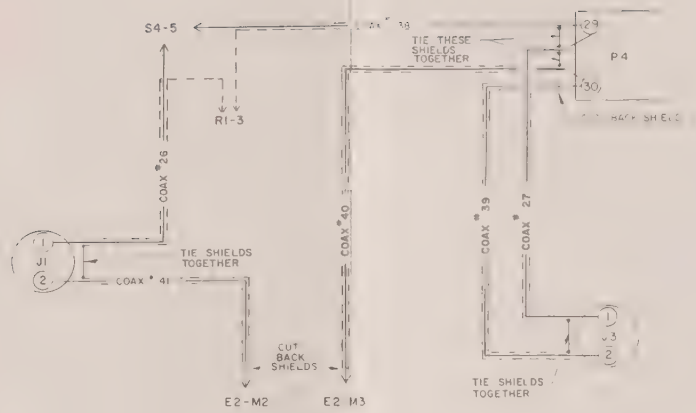

NOTES.
1. E1 IS ± GRD.
E2 IS HIGH QUALITY GRD.
T1
P4
41
43
115V AC
F1
1.25 AMP
OFF
STANDBY
ON
2,7
1,6
5-4
POWER
P3
(EARTH)
CHASSIS GRD
P4-42
2C
115 VAC
2A
2B
115 VAC
B1
FAN
-8V
A10 READOUT STORAGE DECADE 51,080-5 1000'S/ 10,000'S
A9 READOUT STORAGE DECADE 51,010 100'S
A8 READOUT STORAGE DECADE 51,010 10'S
A7 READOUT STORAGE DECADE 51,010 1'S
DS5 ± IND & OVER-RANGE
DS1 1000'S
DS2 100'S
DS3 10'S
DS4 1'S
COM
INDICATORS
P1-50
P2-13
.5VCT
CR12
CR4
CR16
CR8
NW8
C1 4000
E1
C3 2000 µf
POWER SUPPLY REGULATOR 43126-
39VAC
CR9
CR1
+20V
CR13
CR5
R5 20 10W
REGULATOR Q6,Q7
VR1
CR6 1N4169
+20V REG 8V
R31 100 1W
-8V UNREG
R8 100 10W
Q4
Q3
Q2
Q5
36VAC
CR14
CR6
+40V
CR10
CR2
R9 82 2W
REGULATOR Q1,Q2
REGULATOR Q3
REGULATOR Q8,Q9
REGULATOR Q4,Q5
C5 2000 µf
39VAC
CR15
CR7
-20V
CR11
CR3
R6 20 10W
NW8 12.675
TO K2 & K3 COILS 21.4V
R7 33 2W
C4 2000 µf
Q1
+40V
+12V
+2V
-20V
-12V
A6 PROGRAMMER 44.170-4
A5 BINARY COUNTER 44.139 1'S
A4 BINARY COUNTER 44.139 10'S
A3 BINARY COUNTER 44.139 100'S
A2 BINARY COUNTER 44.139-4 1000'S
NW7 12.1064
SHIFT Q1
R12 100K
K1
AUTO RANGE SWITCH A11 14.156-1
BAL "A"
BAL "B"
A1 DUAL D.C. AMPLIFER 6.463-1
R2
R3
CW
E,M,N,Y
E2
P2-3
P2-10
P4-9
P2-11
P2-14
P1-49
P2-5
6.3V AC
COMPARATOR AMPLIFIER & DIODE GATE 26.096-4
THI
A1
R14 470 ± 10% 1/2W
C6 0.5 µf 600V
CHASSIS GRD
P4-37
6.3VAC
220VCT
CR1
CR2
REGULATOR Q1,Q2,Q3
REFERENCE AMPLIFIER 6.464-4
AR2
F200
C2a 200µf
C2b 200µf
C2 20µf
NW6 12.122
BAL REF AMPL
-110V
-100V REF
±GND
P2-1
P2-6
P2-2
P1-47
P2-16
ELECTRONIC ASSOCIATES, INC.
LONG BRANCH NEW JERSEY
SHT NO
SIZE
REV NO
PROJECT 1887
D026 158 05
SHEET 4 OF SHEETS



ELECTRONIC ASSOCIATES INC
LONG BRANCH NEW JERSEY

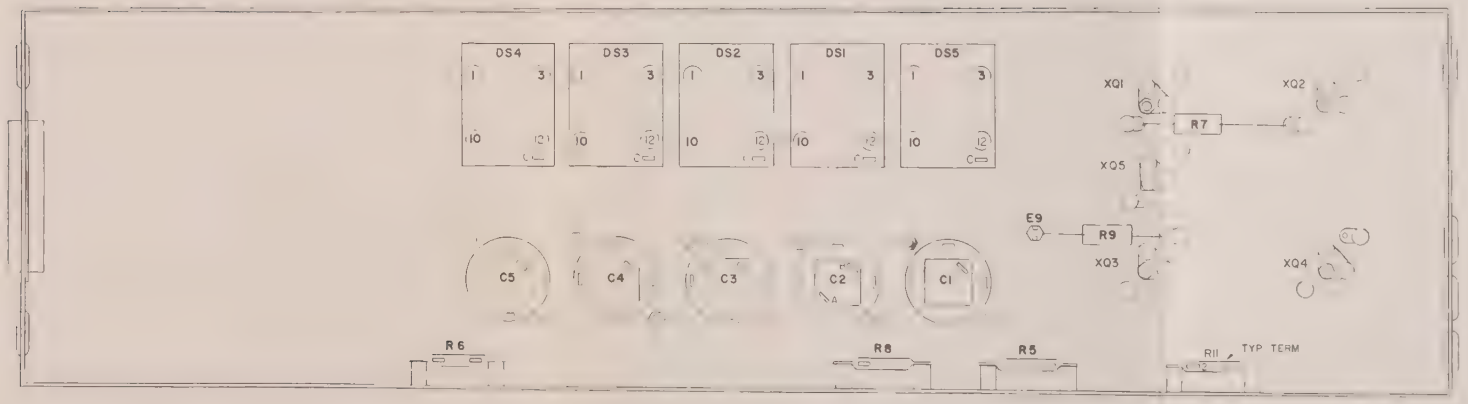
SHT NO	SIZE	REV NO	PROJECT
			1887 D 026 158 OW





VIEW B

VIEW A-A



ELECTRONIC ASSOCIATES, INC
LONG BRANCH NEW JERSEY

SHT NO	
SIZE	
REV NO	
PROJECT	1887 D 026 . 158 0W

SHEET OF SHEETS

AR1-J1 DUAL DC AMPLIFIER 6.463-1 and AR2-J1 REFERENCE AMPLIFIER 6.464-4						
HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1		COLUMN 2	
			DESTINATION	WIRE	DESTINATION	WIRE
18.484;18.482	AR1-J1-A	-20V Output	XQ2-3	WHT-VIO-RED 22	A1-J1-45	WHT-VIO-RED 22
18.484	A	-20V Output	NW7-J1-Z	WHT-VIO-RED 22		
——,18.483	B	Ampl Out "A"	NW7-J1-19	BUS	XK1-16	COAX 5
		COAX 5 Shield	E2-A1	BLK 20		
	C					
18.484	D	+20V Output	VR1-J1-M	WHT-RED-ORN 22	NW7-J1-X	WT-RED-ORN 22
18.483	E	± Grd "B" (DC Ampl)	E2-D1	BLK 16		
18.483	F	Vib Drive (6.3V AC)	T1-12	SHU 1		
	H	Vib Drive Ret.	T1-13	SHU 1 Shield		
18.484	J	+40V Output	C5 (+)	WHT-RED-RED 22		
18.482	K	Bal Pot "A"	R3-2	YEL		
18.482	L	Bal "A" (DC Ampl)	P2-18	YEL		
18.483	M	H.Q. Grd "B" (DC Ampl)	E2-B2	BLK-WHT 16		
18.483	N	H.Q. Grd "A" (DC Ampl)	E2-B1	BLK-WHT 16		
18.482	P	Bal "B" DC Ampl	P2-17	YEL		
18.482	R	Bal Pot "B"	R2-2	YEL		
18.483	S	Ampl Input "A"	NW7-J1-21	BUS		
	T	Key				
	U	Chassis Grd	AR1-J1-Y	BUS		
——,18.483	V	Ampl Input "B"	NW7-J1-10	BUS	NW1-2	COAX 3
		COAX 3 Shield	E2-H1	BLK 20		
	W					
	X					
18.483	Y	± Grd "A" (DC Ampl)	E2-D2	BLK 16	AR1-J1-U	BUS
	AR1-J1-Z	Ampl Out "B"	NW7-J1-9	BUS		
18.483	AR2-J1-A	6.3V AC (Vib Drive)	T1-12	SHU 2		
	B	Vib Drive Ret. (± Grd)	T1-13	SHU 2 Shield		
	C	± Grd	AR2-J1-J	BUS		
18.484	D	220V CT	T1-17	WHT 22		
18.484	E	220V CT	T1-19	WHT 22		
	F	Key				
	H	F.B. Resistor	NW6-3	BUS		
18.483	J	± Grd	E2-G2	BLK 16	AR2-J1-C	BUS
18.484	K	Filter	C2 (-)	WHT 22		
	L	Input	NW6-1	BUS		
18.484	M	-20V	VR1-J1-N	WHT-VIO-RED 22		
	N	-110V	NW6-7	BUS		
	P	Zener Input	NW6-2	BUS		
	R					
18.482	S	Zener Check 9.4V	P2-4	YEL		
18.484	T	+40V	VR1-J1-E	WHT-RED-RED 22	P2-3	WHT-RED-RED 22
	U					
	V					
	W	-100V Ref.	NW6-4	BUS		
	X					
18.482	Y	Bal.	P2-1	BLK		
18.483	AR2-J1-Z	H.Q. Grd	E2-C1	BLK-WHT 16		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV NO.	
PROJECT 1887	B 026 158 0W

SHEET 4 OF SHEETS

A1-J1 COMPARATOR and DIODE GATE 26.096-4

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A1-J1-1	Sum Junction	NW2-J1-E	COAX 6		
18.482	2	8000 In	V	RED		
	3	4000	U	ORN		
	4	2000	T	YEL		
	5	1000	S	GRN		
	6	800	R	BLU		
	7	400	P	VIO		
	8	200	N	GY		
	9	100	M	WHT		
	10	80	D	BLK		
	11	40	C	BRN		
	12	20	B	RED		
	13	10	A	WHT 20 *		
	14	8	Z	BLK 20 *		
	15	4	Y	BRN 20 *		
	16	2	X	RED 20 *		
	17	1 In	NW2-J1-W	ORN 20 *		
	18	8000 Gate	A2-J1-X	GY		
	19	4000	A2-J1-U	WHT		
	20	2000	A2-J1-S	BLK		
	21	1000	A2-J1-J	BRN		
	22	800	A3-J1-X	RED		
	23	400	A3-J1-U	ORN		
	24	200	A3-J1-S	YEL		
	25	100	A3-J1-J	GRN		
	26	80	A4-J1-X	BLU		
	27	40	A4-J1-U	VIO		
	28	20	A4-J1-S	GY		
	29	10	A5-J1-J	WHT		
	30	8	A5-J1-X	BLK		
	31	4	A4-J1-J	BRN		
	32	2	A5-J1-S	RED		
	33	1 Gate	A5-J1-J	ORN		
	34	Zero Set	R1-2	GRN		
	35	H.Q. Grd	E2-L2	BLK-WHT 20		
	36					
	37					
	38					
	39	± Grd	E2-L3	BLK 20		
	40					
	41					
	42					
	43					
	44					
	45	-20V	AR1-J1-A	WHT-VIO-RED 22		
	46					
	47	Comparator (-) Out	A6-J1-R	COAX 35		
	48					
18.482	49	Comparator (+) Out	A6-J1-N	COAX 36		
	A1-J1-50					

3

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV. NO	
PROJECT 1887	B 026 158 0W

SHEET 5 OF SHEETS

A2-J1 BINARY CODED DECADE COUNTER 44.139-4 (1000's) A3-J1 BINARY CODED DECADE COUNTER 44.139- (100's)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A2-J1-A	Carry In	A2-J1-N	BUS		
18.484	B	+12V	A3-J1-B	BUS	NW7-J1-B	WHT-RED-ORN 22
	C	Count	A3-J1-C	BUS		
	D	Shift	A3-J1-D	BUS		
	E					
18.482	F	Carry Out	A3-J1-A	YEL	A3-J1-R	YEL
	H	1'	A10-J1-B	ORN		
	J	1	A10-J1-C	BRN	A1-J1-21	BRN
18.482	K	2'	A10-J1-D	RED		
18.484	L	-12V	A3-J1-L	BUS	NW7-J1-A	WHT-VIO-ORN 22
	M	Pull Over	A3-J1-M	BUS		
	N	Zero Set	A3-J1-N	BUS	A2-J1-A	BUS
18.483	P	± Grd	A3-J1-P	BUS	C4 (+)	BLK 16
	R					
18.482	S	2	A10-J1-E	BLK	A1-J1-20	BLK
18.482	T	4'	A10-J1-K	GRN		
	U	4	A10-J1-F	WHT	A1-J1-19	WHT
	V	8'	A10-J1-H	YEL		
	W	Key				
18.482	X	8	A10-J1-J	GY	A1-J1-18	GY
18.484	Y	+2V	A3-J1-Y	BUS	NW7-J1-C	WHT-RED-BLU 22
	A2-J1-Z					
18.482	A3-J1-A	Carry In	A2-J1-F	YEL		
	B	+12V	A2-J1-B	BUS	A4-J1-B	BUS
	C	Count	A2-J1-C	BUS	A4-J1-C	BUS
	D	Shift	A2-J1-D	BUS	A4-J1-D	BUS
	E					
18.482	F	Carry Out	A4-J1-A	YEL		
	H	1'	A9-J1-B	BRN		
	J	1	A9-J1-C	GRN	A1-J1-25	GRN
18.482	K	2'	A9-J1-D	BLU		
	L	-12V	A2-J1-L	BUS	A4-J1-L	BUS
	M	Pull Over	A2-J1-M	BUS	A4-J1-M	BUS
	N	Zero Set	A2-J1-N	BUS	A4-J1-N	BUS
	P	± Grd	A2-J1-P	BUS	A4-J1-P	BUS
18.482	R	Nine Set	A4-J1-R	BUS	A2-J1-F	YEL
	S	2	A9-J1-E	YEL	A1-J1-24	YEL
	T	4'	A9-J1-K	GY		
	U	4	A9-J1-F	ORN	A1-J1-23	ORN
	V	8'	A9-J1-H	VIO		
	W	Key				
18.482	X	8	A9-J1-J	RED	A1-J1-22	RED
	Y	+2V	A2-J1-Y	BUS	A4-J1-Y	BUS
	A3-J1-Z					

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV NO	
PROJECT 1887	B 026 158 0W

SHEET 6 OF SHEETS

A4-J1 BINARY CODED DECADE COUNTER 44.139 (10's) A5-J1 BINARY CODED DECADE COUNTER 44.139 (1's)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.482	A4-J1-A	Carry In	A3-J1-F	YEL	A11-J1-S	YEL
	B	+12V	A3-J1-B	BUS	A5-J1-B	BUS
	C	Count	A3-J1-C	BUS	A5-J1-C	BUS
	D	Shift	A3-J1-D	BUS	A5-J1-D	BUS
	E					
18.482	F	Carry Out	A5-J1-A	YEL		
	H	1'	A8-J1-B	BRN		
	J	1	A8-J1-C	WHT	A1-J1-29	WHT
18.482	K	2'	A8-J1-D	RED		
	L	-12V	A3-J1-L	BUS	A5-J1-L	BUS
	M	Pull Over	A3-J1-M	BUS	A5-J1-M	BUS
	N	Zero Set	A3-J1-N	BUS	A5-J1-N	BUS
	P	± Grd	A3-J1-P	BUS	A5-J1-P	BUS
	R	Nine Set	A3-J1-R	BUS	A5-J1-R	BUS
18.482	S	2	A8-J1-E	GY	A1-J1-28	GY
	T	4'	A8-J1-K	GRN		
	U	4	A8-J1-F	VIO	A1-J1-27	VIO
	V	8'	A8-J1-H	ORN		
	W	Key				
18.482	X	8	A8-J1-J	BLU	A1-J1-26	BLU
	Y	+2V	A3-J1-Y	BUS	A5-J1-Y	BUS
	A4-J1-Z					
18.482	A5-J1-A	Carry In	A4-J1-F	YEL		
	B	+12V	A4-J1-B	BUS	A6-J1-B	BUS
18.482	C	Count	A4-J1-C	BUS	A6-J1-S	YEL
18.482	D	Shift	A4-J1-D	BUS	A6-J1-P	YEL
	E					
18.482	F	Carry Out	A6-J1-A	YEL		
	H	1'	A7-J1-B	VIO		
	J	1	A7-J1-C	ORN	A1-J1-33	ORN
18.482	K	2'	A7-J1-D	BLU		
	L	-12V	A4-J1-L	BUS	A6-J1-L	BUS
18.482	M	Pull Over	A4-J1-M	BUS	A6-J1-H	YEL
18.482	N	Zero Set	A4-J1-N	BUS	A6-J1-J	YEL
	P	± Grd	A4-J1-P	BUS		
	R	Nine Set	A4-J1-R	BUS		
18.482	S	2	A7-J1-E	RED	A1-J1-32	RED
	T	4'	A7-J1-K	YEL		
	U	4	A7-J1-F	BRN	A1-J1-31	BRN
	V	8'	A7-J1-H	GRN		
	W	Key				
18.482	X	8	A7-J1-J	BLK	A1-J1-30	BLK
18.484	Y	+2V	A4-J1-Y	BUS	P2-10	WHT-RED-BLU 22
	A5-J1-Z					

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ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV NO.	
PROJECT 1887	B 026 158 0W
SHEET 7 OF SHEETS	

A6-J1 PROGRAMMER 44.170-4

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.482	A6-J1-A	Carry In	A5-J1-F	YEL	P2-15	YEL
18.484	B	+12V	A5-J1-B	SD-BUS	P2-11	WHT-RED-ORN 22
	C	Key				
18.482	D	Hold	S5-10	YEL		
	E	Ind Clear	NW7-J1-7	YEL	P2-7	YEL
	F	Relay Coil	XK1-4	BLU	P4-24	BLU 20
	H	Pull Over	A5-J1-M	YEL	A11-J1-P	YEL
	H	Pull Over	NW7-J1-6	YEL		
	J	Carry Out	A5-J1-N	YEL	A11-J1-R	YEL
	J	Carry Out (0 Set)	NW7-J1-4	YEL		
18.482	K	-1 Digit	NW2-J1-F	YEL		
18.484	L	-12V	A5-J1-L	SD-BUS	VR1-J1-P	WHT-VIO-ORN 22
18.482	M	Relay Arm	XK1-9	YEL	P1-74	YEL
	N	Comparator (+)	A1-J1-49	COAX 36		
	P	Shift	A5-J1-D	YEL		
	R	Comparator (-)	A1-J1-47	COAX 35		
	S	Count	A5-J1-C	YEL		
	T					
	U	Cycle Command	S5-5	YEL		
	V	(+) Relay	XK1-10	YEL		
	W	(+) Ind.	NW7-J1-1	YEL		
	X	(-) Ind.	NW7-J1-2	YEL		
18.482	Y	(-) Relay	XK1-8	YEL		
18.483	A6-J1-Z	± Grd	E1-A5	BLK 16		COAX 35 SHIELD
	Z	± Grd		COAX 36 SHIELD		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

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PROJECT 1887	B 026 158 0W

SHEET 8 OF SHEETS

A7-J1 READOUT STORAGE DECADE 51.010 (1's)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.482	A7-J1-A	-8V	A8-J1-A	BUS	P1-50	WHT-VIO-BLU 20
18.482	B	1' Input(Binary Coded)	A5-J1-H	VIO		
	C	1	A5-J1-J	ORN		
	D	2'	A5-J1-K	BLU		
	E	2	A5-J1-S	RED		
	F	4	A5-J1-U	BRN		
	H	8'	A5-J1-V	GRN		
	J	8	A5-J1-X	BLK		
18.482	K	4' Input(Binary Coded)	A5-J1-T	YEL		
	L	Shift	A8-J1-L	BUS		
	M	± Grd	A8-J1-M	BUS		
	N	Key				
18.481	P	0 Output(Digital)	DS4-10	BLK	P1-1	BLK
	R	1 Output	DS4-1	BRN	P1-2	BRN
	S	2 Output	DS4-2	RED	P1-3	RED
	T	3 Output	DS4-3	ORN	P1-4	ORN
	U	4 Output	DS4-4	YEL	P1-5	YEL
	V	5 Output	DS4-5	GRN	P1-6	GRN
	W	6 Output	DS4-6	BLU	P1-7	BLU
	X	7 Output	DS4-7	VIO	P1-8	VIO
	Y	8 Output	DS4-8	GY	P1-9	GY
18.481	A7-J1-Z	9 Output (Digital)	DS4-9	WHT	P1-10	WHT
	A7-J1-1					
18.481	2	1'(Binary Coded Outputs)	P1-51	WHT-RED		
	3					
	4	2'	P1-52	WHT-BRN		
	5					
	6					
	7	8'	P1-54	WHT-VIO		
	8					
18.481	9	4'(Binary Coded Outputs)	P1-53	WHT-GY		
	10					
	11					
	12					
	13					
	14					
	15					
	15					
	17					
	18					
	19					
	20					
	21					
	A7-J1-22					

ELECTRONIC ASSOCIATES, INC.
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REV NO.
PROJECT 1887 B 026 158 0W
SHEET 9 OF SHEETS

A8-J1 READOUT STORAGE DECADE 51.010 (10's)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A8-J1-A	-8V	A7-J1-A	BUS	A9-J1-A	BUS
18.482	B	1' Input(Binary Coded)	A4-J1-H	BRN		
	C	1	A4-J1-J	WHT		
	D	2'	A4-J1-K	RED		
	E	2	A4-J1-S	GY		
	F	4	A4-J1-U	VIO		
	H	8'	A4-J1-V	ORN		
	J	8	A4-J1-X	BLU		
18.482	K	4' Input (Binary Coded)	A4-J1-T	GRN		
	L	Shift	A7-J1-L	BUS	A9-J1-L	BUS
18.483	M	± Grd	C1 (+)	BLK 16	A7-J1-M	BUS
	N	Key				
18.481	P	0 Output(Digital)	DS3-10	BLK	P1-11	BLK
	R	1 Output	DS3-1	BRN	P1-12	BRN
	S	2 Output	DS3-2	RED	P1-13	RED
	T	3 Output	DS3-3	ORN	P1-14	ORN
	U	4 Output	DS3-4	YEL	P1-15	YEL
	V	5 Output	DS3-5	GRN	P1-16	GRN
	W	6 Output	DS3-6	BLU	P1-17	BLU
	X	7 Output	DS3-7	VIO	P1-18	VIO
	Y	8 Output	DS3-8	GY	P1-19	GY
18.481	A8-J1-Z	9 Output (Digital)	DS3-9	WHT	P1-20	WHT
	A8-J1-1					
18.481	2	1'(Binary Coded Outputs)	P1-55	WHT-RED		
	3					
	4	2'	P1-56	WHT-BRN		
	5					
	6					
	7	8'	P1-58	WHT-VIO		
	8					
18.481	9	4'(Binary Coded Outputs)	P1-57	WHT-GY		
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	A8-J1-22					

ELECTRONIC ASSOCIATES, INC.
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REV NO.
PROJECT 1887 B 026 158 0W
SHEET 10 OF SHEETS

A9-J1 READOUT STORAGE DECADE 51.010 (100's)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A9-J1-A	-8V	A8-J1-A	BUS	A10-J1-A	-BUS
18.482	B	1' Input(Binary Coded)	A3-J1-H	BRN		
	C	1	A3-J1-J	GRN		
	D	2'	A3-J1-K	BLU		
	E	2	A3-J1-S	YEL		
	F	4	A3-J1-U	ORN		
	H	8'	A3-J1-V	VIO		
	J	8	A3-J1-X	RED		
18.482	K	4' Input(Binary Coded)	A3-J1-T	GY		
	L	Shift	A8-J1-L	BUS	A10-J1-L	BUS
	M	± Grd	A10-J1-M	BUS		
	N	Key				
18.481	P	0 Output (Digital)	DS2-10	BLK	P1-21	BLK
	R	1 Output	DS2-1	BRN	P1-22	BRN
	S	2 Output	DS2-2	RED	P1-23	RED
	T	3 Output	DS2-3	ORN	P1-24	ORN
	U	4 Output	DS2-4	YEL	P1-25	YEL
	V	5 Output	DS2-5	GRN	P1-26	GRN
	W	6 Output	DS2-6	BLU	P1-27	BLU
	X	7 Output	DS2-7	VIO	P1-28	VIO
	Y	8 Output	DS2-8	GY	P1-29	GY
18.481	A9-J1-Z	9 Output (Digital)	DS2-9	WHT	P1-30	WHT
	A9-J1-1					
18.481	2	1'(Binary Coded Outputs)	P1-59	WHT-RED		
	3					
	4	2'	P1-60	WHT-BRN		
	5					
	6					
	7	8'	P1-62	WHT-VIO		
	8					
18.481	9	4'(Binary Coded Outputs)	P1-61	WHT-GY		
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	A9-J1-22					

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ELECTRONIC ASSOCIATES, INC.
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SHEET 11 OF SHEETS

A10-J1 READOUT STORAGE DECADE 51.080-5 (1000's)/(10,000's)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.484	A10-J1-A	+8V	DSS-C	WHT-VIO-BLU 20		
18.484	-A	-8V	A9-J1-A	BUS	XQ5-3	WHT-VIO-BLU 20
18.482	B	1 Input(Binary Coded)	A2-J1-H	ORN	A11-J1-D	ORN
	C	1	A2-J1-J	BRN		
	D	2'	A2-J1-K	RED	A11-J1-E	RED
	E	2	A2-J1-S	BLK		
	F	4	A2-J1-U	WHT	A11-J1-U	WHT
	H	8'	A2-J1-V	YEL	A11-J1-H	YEL
	J	8	A2-J1-X	GY	A11-J1-T	GY
	K	4' Input(Binary Coded)	A2-J1-T	GRN	A11-J1-F	GRN
18.482	L	Shift	A9-J1-L	BUS	NW7-J1-3	YEL
	M					
18.483	M	± Grd	A9-J1-M	BUS	A11-J1-W	BLK 16
	N	Key				
18.481	P	0 Output(Digital)	DS1-10	BLK	P1-31	BLK
	R	1 Output	DS1-1	BRN	P1-32	BRN
	S	2 Output	DS1-2	RED	P1-33	RED
	T	3 Output	DS1-3	ORN	P1-34	ORN
	U	4 Output	DS1-4	YEL	P1-35	YEL
	V	5 Output	DS1-5	GRN	P1-36	GRN
	W	6 Output	DS1-6	BLU	P1-37	BLU
	X	7 Output	DS1-7	VIO	P1-38	VIO
	Y	8 Output	DS1-8	GY	P1-39	GY
18.481	A10-J1-Z	9 Output(Digital)	DS1-9	WHT	P1-40	WHT
18.481	A10-J1-1	1' (10,000's)	P1-67	YEL		
	2	1'(Binary Coded Output)	P1-63	WHT-RED		
	3					
	4	2'	P1-64	WHT-BRN		
	5					
	6					
	7	8'	P1-66	WHT-VIO		
	8					
	9	4'(Binary Coded Output)	P1-65	WHT-GY		
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21	1'(Digital Output)	DS5-12	WHT-VIO	P1-42	WHT-VIO
18.481	A10-J1-22	0'(Digital Output)	DS5-3	OR	P1-41	OR

ELECTRONIC ASSOCIATES, INC.
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SHEET 12 OF SHEETS

A11-J1 AUTOMATIC RANGE SWITCH 14.156-1

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.481	A11-J1-A	A.R.S Com (K2)	P4-2	RED		
18.481	B	Auto	P4-4	YEL	S3-3	YEL
	C	100's Mult (Down Range)	A11-J1-S	BUS		
18.482	D	1000 Gate	A10-J1-B	ORN		
	E	2000 Gate	A10-J1-D	RED		
	F	4000 Gate	A10-J1-K	GRN		
18.482	H	8000 Gate (Down Range)	A10-J1-H	YEL		
18.481	J	Relay Drive (K2)	K2-14	BLU	P4-21	BLU 20
	K	Manual Protects	P4-5	GRN	S3-7	GRN
	L	K3 Relay Drive	P4-7	BLU	S3-5	BLU
18.481	M	A.R.S Com (K3)	P4-1	BRN		
	N	Key				
18.482	P	Pull Over	A6-J1-H	YEL		
	R	Sign Check Inhibit	A6-J1-J	YEL		
	S	100's Mult Out (Up Rge)	A4-J1-A	YEL	A11-J1-C	BUS
	T	8000 Gate (Up Range)	A10-J1-J	GY		
18.482	U	4000 Gate (Up Range)	A10-J1-F	WHT		
18.481	V	Over Range Ind.	DS5-11	WHT-BRN	P4-10	WHT-BRN
18.483	W	± Grd	C1 (+)	BLK-16	A10-J1-M	BLK 16
18.484	X	+ 2V	VR1-J1-T	WHT-RED-BLU 22		
	Y	+ 12V	VR1-J1-S	WHT-RED-ORN 22		
18.484	A11-J1-Z	- 12V	VR1-J1-P	WHT-VIO-ORN 22	P1-49	WHT-VIO-ORN 22
	A11-J1-1					
	2					
	3					
	4					
	5					
	6					
	7					
18.482	8	ARS Com (K2)	NW7-J1-5	RED		
	9					
18.481	10	AC Mono Cap	P4-25	COAX 33		
	11					
	12					
	13					
18.481	14	AC Mono Cap	P4-26	COAX 34		
18.481	15	AC Mono Cap	P4-28	COAX 36		
18.481	16	AC Mono Cap	P4-27	COAX 35		
	17					
	18					
	19					
	20					
	21					
	A11-J1-22					

ELECTRONIC ASSOCIATES, INC.
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SHEET 13 OF SHEETS

DS1 - DS3 (INDICATOR DISPLAY UNITS)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.481	DS1-1	1(Digital Output)	A10-J1-R	BRN		
	2	2	S	RED		
	3	3	T	ORN		
	4	4	U	YEL		
	5	5	V	GRN		
	6	6	W	BLU		
	7	7	X	VIO		
	8	8	Y	GY		
	9	9	Z	WHT		
	10	10Digital Output)	A10-J1-P	BLK		
18.481	11	Dec.Ind (1V)	K3-6	WHT-BRN	P1-43	WHT-BRN
	12					
	DS1-COM	Ind Com	DS5-COM	BUS 20	DS2-COM	BUS 20
18.481	DS2-1	1(Digital Output)	A9-J1-R	BRN		
	2	2	S	RED		
	3	3	T	ORN		
	4	4	U	YEL		
	5	5	V	GRN		
	6	6	W	BLU		
	7	7	X	VIO		
	8	8	Y	GY		
	9	9	Z	WHT		
	10	10(Digital Output)	A9-J1-P	BLK		
18.481	11	Dec. Ind (10V)	K3-4	WHT-RED	P1-44	WHT-RED
	12					
	DS2-COM	Ind Com	DS1-COM	BUS 20	DS3-COM	BUS 20
18.481	DS3-1	1(Digital Output)	A8-J1-R	BRN		
	2	2	S	RED		
	3	3	T	ORN		
	4	4	U	YEL		
	5	5	V	GRN		
	6	6	W	BLU		
	7	7	X	VIO		
	8	8	Y	GY		
	9	9	Z	WHT		
	10	10(Digital Output)	A8-J1-P	BLK		
18.481	11	Dec. Ind (100V)	K3-1	WHT-VIO	P1-45	WHT-VIO
	12					
	DS3-COM	Ind Com	DS2-COM	BUS 20	DS4-COM	BUS 20

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SHEET 14 OF SHEETS

DS4 - DS5 (INDICATOR DISPLAY UNITS)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.481	DS4-1	1 (Digital Output)	A7-J1-R	BRN		
	2	2	S	RED		
	3	3	T	ORN		
	4	4	U	YEL		
	5	5	V	GRN		
	6	6	W	BLU		
	7	7	X	VIO		
	8	8	Y	GY		
	9	9	Z	WHT		
	10	0 (Digital Output)	A7-J1-P	BLK		
18.481	11	Dec. Ind (1000V)	K3-3	WHT-GY	P1-46	WHT-GY
	12					
	DS4-COM	Ind Com	DS3-COM	BUS 20		
18.482;18.481	DS5-1	(+) Ind	XK1-7	BRN	P1-70	BRN
	2					
18.481	3	0'	A10-J1-22	ORN		
	4					
	5					
18.481	6	Spare	P1-78	BLU		
	7					
18.481	8	AC Ind Grd	P4-17	BLK 22		
	9					
18.482;18.481	10	(-) Ind	XK1-5	BLK	P1-71	BLK
18.481	11	Over Range Ind	A11-J1-V	WHT-BRN		
18.481	12	1' 10,000's	A10-J1-21	WHT-VIO		
18.484	DS5-COM	Ind Common	DS1-COM	BUS 20	A10-J1-A	WHT-VIO-BLU 20

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SHEET 15 OF SHEETS

P1 PRINTER

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.481	P1-1	0 Digital Output	A7-J1-P	BLK		
	2	1	R	BRN		
	3	2	S	RED		
	4	3	T	ORN		
	5	4	U	YEL		
	6	5	V	GRN		
	7	6	W	BLU		
	8	7	X	VIO		
	9	8	Y	GY		
	10	9	A7-J1-Z	WHT		
	11	0	A8-J1-P	BLK		
	12	1	R	BRN		
	13	2	S	RED		
	14	3	T	ORN		
	15	4	U	YEL		
	16	5	V	GRN		
	17	6	W	BLU		
	18	7	X	VIO		
	19	8	Y	GY		
	20	9	A8-J1-Z	WHT		
	21	0	A9-J1-P	BLK		
	22	1	R	BRN		
	23	2	S	RED		
	24	3	T	ORN		
	25	4	U	YEL		
	26	5	V	GRN		
	27	6	W	BLU		
	28	7	X	VIO		
	29	8	Y	GY		
	30	9	A9-J1-Z	WHT		
	31	0	A10-J1-P	BLK		
	32	1	R	BRN		
	33	2	S	RED		
	34	3	T	ORN		
	35	4	U	YEL		
	36	5	V	GRN		
	37	6	W	BLU		
	38	7	X	VIO		
	39	8	Y	GY		
18.481	P1-40	9 (Digital Output)	A10-J1-Z	WHT		

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SHEET 16 OF SHEETS

P1 CONT'D PRINTER

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.481	P1-41	0' Digital Out (1,000's)	A10-J1-22	GR		
	42	1' Digital Out (1,000's)	A10-J1-21	WHT-VIO		
	43	Dec. Ind (1V)	DS1-11	WHT-BRN	P4-11	WHT-BRN
	44	Dec. Ind (10V)	DS2-11	WHT-RED	P4-12	WHT-RED
	45	Dec. Ind (100V)	DS3-11	WHT-VIO	P4-13	WHT-VIO
	46	Dec. Ind (1000V)	DS4-11	WHT-GY	P4-19	WHT-GRY
	47	± Grd	E1-A3	BLK 16	P2-16	BLK 20
18.481	48	Carry In	P2-15	YEL		
18.484	49	-12V	A11-J1-Z	WHT-VIO-ORN 22	P2-14	WHT-VIO-ORN 22
18.484	50	-8V	A7-J1-A	WHT-VIO-BLU 20	P2-13	WHT-VIO-BLU 20
18.481	51	1'(1's) (BinaryCodeOutp)	A7-J1-2	WHT-RED		
	52	2'(1's)	A7-J1-4	WHT-BRN		
	53	4'(1's)	A7-J1-9	WHT-GY		
	54	8'(1's)	A7-J1-7	WHT-VIO		
	55	1'(10's)	A8-J1-2	WHT-RED		
	56	2'(10's)	A8-J1-4	WHT-BRN		
	57	4'(10's)	A8-J1-9	WHT-GY		
	58	8'(10's)	A8-J1-7	WHT-VIO		
	59	1'(100's)	A9-J1-2	WHT-RED		
	60	2'(100's)	A9-J1-4	WHT-BRN		
	61	4'(100's)	A9-J1-9	WHT-GY		
	62	8'(100's)	A9-J1-7	WHT-VIO		
	63	1'(1000's)	A10-J1-2	WHT-RED		
	64	2'(1000's)	A10-J1-4	WHT-BRN		
	65	4'(1000's)	A10-J1-9	WHT-GY		
	66	8'(1000's)	A10-J1-7	WHT-VIO		
	67	1'(10,000's) (BinCodeOtp)	A10-J1-1	YEL		
	68	Hold	NW7-J1-8	YEL		
	69	Ind Clear	P2-7	YEL		
	70	(+) Ind	DS5-1	BRN		
	71	(-) Ind	DS5-10	BLK		
	72	Over Range	P4-10	WHT-BRN		
18.481	73	AC Ind Grd	P4-17	BLK 22		
18.482	74	Polarity Hold	A6-J1-M	YEL		
	75					
	76					
	77					
18.481	P1-78	Spare	DS5-6	BLU		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT NO	
SIZE	
REV NO	
PROJECT 1887	B 026 158 0W

SHEET 17 OF SHEETS

P2 TEST POINTS			P3 AC INPUT(LINE)			
			COLUMN 1		COLUMN 2	
HARN/CABLE	TERMINAL	FUNCTION	DESTINATION	WIRE	DESTINATION	WIRE
18.482	P2-1	Bal Ref Ampl	AR2-J1-Y	BLK		
18.484	2	-100V Ref	S2a-C	WHT-VIO 22		
18.484	3	+40V	AR2-J1-T	WHT-RED-RED 22		
18.482	4	9.4V Zen Chk	AR2-J1-S	YEL		
18.484	5	-20V	R2-1	WHT-VIO-RED 22		
18.484	6	-110V	NW6-7	WHT 22		
18.482;18,481	7	Ind Clear	A6-J1-E	YEL	P1-69	YEL
18.483	8	Ampl Out "A"	NW7-J1-19	COAX 12		
18.483	9	Ampl Out "B"	NW7-J1-9	COAX 13		
18.484	10	+2V	A5-J1-Y	WHT-RED-BLU 22		
18.484	11	+12V	P4-9	WHT-RED-ORN 22	A6-J1-B	WHT-RED-ORN 22
	12	+20V	VR1-J1-M	WHT-RED-ORN 22		
	13	-8V	P1-50	WHT-VIO-BLU 20		
18.484	14	-12V	P1-49	WHT-VIO-ORN 22		
18.481;18,482	15	Carry In	P1-48	YEL	A6-J1-A	YEL
18.481	16	+ Grd	P1-47	BLK 20		
18.482	17	Bal " B" (DC Ampl)	AR1-J1-P	YEL		
18.482	18	Bal "A" (DC Ampl)	AR1-J1-L	YEL		
	19					
	20					
	21					
	22					
	23					
	24					
	P2-25					
	P3-0	115V AC (Hot)	XF1-1	* (0) BLK		
	P3-5	Earth Grd	E4 Lug	* (5) GRN		
	P3-9	115V AC (Com)	E4	* (9) WHT		

*Refers Color Leads of Power Cord:
(0) Black - AC Line (Hot)
(5) Green - Earth Ground
(9) White - AC Line (Com)

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
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PROJECT 1887	B 026 158 0W

SHEET 18 OF SHEETS

* See detail "B" on Sheet 3 for critical coax shield terminations.

P4 PROGRAMMING

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.481	P4-1	A.R.S. Com (K3)	A11-J1-M	BRN		
	2	A.R.S. Com (K2)	A11-J1-A	RED		
	3	Remote	S3-2	ORN		
	4	Auto	A11-J1-B	YEL		
	5	1V Range	A11-J1-K	GRN		
	6	10V Range	S3-6	VIO		
18.481	7	100V Range	A11-J1-L	BLU		
18.482	8	Ext Cycle Com	S5-3	GY		
18.484	9	+12V	P2-11	WHT-RED-ORN 22	VR1-J1-S	WHT-RED-ORN 22
18.481	10	Over Range	A11-J1-V	WHT-BRN	P1-72	WHT-BRN
18.481	11	Dec Ind (1V)	P1-43	WHT-BRN		
18.481	12	Dec Ind (10V)	P1-44	WHT-RED		
18.481	13	Dec Ind (100V)	P1-45	WHT-VIO		
	14					
18.482	15	Dec Point Grd	E-7	BLK 22		BUS
18.482	16	± Ind Grd	E-8	BLK 22		BUS
18.481	17	AC Ind Grd	DS5-8	BLK 22	P1-73	BLK 22
	18					
18.481	19	Dec Ind (1000V)	P1-46	WHT-GRY 22		
18.484	20	-8V Grd	NW8-11	BLK 20		
18.481	21	Range Card Auto	A11-J1-J	BLU 20		
	22					
	23					
18.482	24	Sign Relay Lock	A6-J1-F	BLU 20		
18.481	25	AC Mono Cap	A11-J1-10	COAX 33	Grd COAX Shields on BUS between P4-37 & 45	
	26		-14	34		
	27		-16	35		
18.481	28	AC Mono Cap	A11-J1-15	36		
18.483,——	29	Input	S4-5	COAX 38	*	COAX 38 Shield
18.483,——	29	Input	J3-1	COAX 27	*	COAX 27 Shield
	30	Conn Grd	J3-2	COAX 39		
	30	Conn Grd	E2-M3	COAX 40	*	COAX 40 Shield
	31					
	32					
	33					
	34					
	35					
	36					
18.481	37	Function Grd				SD-BUS #16
	38					
	39					
	40					
18.481	41	115V AC Hot	XF1-1	BLK 16		
	42	115V AC Com.	E4	WHT 16		
	43	Earth Grd	E4-Lug	GRN 16		
	44	Functional Grd	E2-J1	BLK-WHT 16		BUS
18.483;18.481	P4-45	Functional Grd (COAX Shields)	E1-B10	BLK 18		

ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
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PROJECT 1887	B 026 158 UW
SHEET 19 OF SHEETS	

NW7-J1 NETWORK CARD (MISC.) 12.1064

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.482	NW7-J1-1	(+) Ind	A6- J1-W	YEL		
↕	2	(-) Ind	A6-J1-X	YEL		
18.482	3	Shift (RSD)	A10-J1-L	YEL		
18.482	4	Carry Out (0 Set)	A6-J1-J	YEL		
18.482	5	A.R.S. Com(K2)	A11-J1-8	RED		
18.482	6	Pull Over	A6-J1-H	YEL		
18.482	7	Ind Clear	A6-J1-E	YEL		
18.482	8	Hold	P1-68	YEL		
18.483	9	Ampl Out "B"	AR1-J1-Z	BUS	P2-9	COAX 13
18.483	9	Ampl Out "B"	NW1-4	COAX 1		
		COAX 1 Shield	E2-K2	BLK 20		
		COAX 13 Shield	E2-K3	BLK 20		
	10	Ampl Inp "B"	AR1-J1-V	BUS		
	11					
18.483	12	Input 1V	S8-6	COAX 14		
		Coax 14 Shield	E2 J3	BLK 20		
	13	Key				
18.483	14	Input 10V	S8-3	COAX 15		
		Coax 15 Shield	E2-J2	BLK 20		
18.483	15	Unloading 10V	S8-2	COAX 16		
		Coax 16 Shield	E2-G3	BLK 20		
18.483	16	Unloading (1) 1V	NW1-11	COAX 17		
		Coax 17 Shield	E2-F3	BLK 20		
	17	Summing Junction	NW2-J1-E	COAX 18		
18.483	18	Full Scale Adj	E12	COAX 19		
		Coax 19 Shield	E2-E3	BLK 20		
——.18.483	19	Ampl Out "A"	AR1-J1-B	BUS	P2-8	COAX 12
		Coax 12 Shield	E2-C3	BLK 20		
18.483	20	Input (Sum. Resistor)	NW2-J1-H	COAX 20		
		Coax 20 Shield	E2- E3	BLK 20		
	21	Ampl Inp "A"	AR1-J1-S	BUS		
	22					
18.484	A	-12V	A2-J1-L	WHT-VIO-ORN 22		
↕	B	+12	A2-J1-B	WHT-RED-ORN 22		
18.484	C	+2V	A2-J1-Y	WHT-RED-BLU 22	R8-1	WHT-RED-BLU 22
	D					
	E					
	F					
	H					
	J					
	K					
	L					
	M					
	N					
	P					
	R					
	S					
	T					
	U					
	V					
	W					
18.484	X	+20V	AR-J1-D	WHT-RED-ORN 22		
18.483	Y	± Grd	E2-H3	BLK 16		
18.484	NW7-J1-Z	-20V	AR1-J1-A	WHT-VIO-RED 22		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV. NO.	
PROJECT 1887	B 026 158 0W

SHEET 20 OF SHEETS

NW1 INPUT RESISTOR NETWORK, NW6 Ref Ampl Net, NW8 Rect. Net,

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	NW1-1	1000V/100V Input	K2-12	BUS 20		
18.483	2	Ampl Input "B"	AR1-J1-V	COAX 3		
	3	10V/1V Input	K2-10	BUS 20		
——,18.483	4	Output "B"	K3-11	BUS 20	NW7-J1-9	COAX #1
	5	1000V/10V F.B.	K2-8	BUS 20		
	6	1V Unl'd Input	K3-9	BUS 20		
__18.483	7	1V Unl'd Output	NW1-10	BUS 20	S8-5	COAX 31
	8	10V Unl'd Input	K3-7	BUS 20		
	9	10V Unl'd Output	S8-2	COAX 30		
	10	1V Unl'd Input	NW1-7	BUS 20		
18.483	NW1-11	1V Unl'd Output	NW7-J1-16	COAX 17		
		NW6 REF AMPL NETWORK 12.722				
	NW6-1	Input	AR2-J1-L	BUS		
	2	Zener Input	AR2-J1-P	BUS		
	3	F.B. Resistor	AR2-J1-H	BUS		
18.484	4	-100V Ref	AR2-J1-W	BUS	S2a-C	WHT-VIO 22
	5	Zero Set	R1-1	WHT-VIO 22		
18.484	6	-100V Ref (Ext)	S2b-C	WHT-VIO 22		
18.484	7	Filter(-110)	AR2-J1-N	BUS	P2-6	WHT 22
18.483	NW6-8	Filter Grd (-110)	T1-18	BLK 16		
		NW8 RECTIFIER NETWORK 12.675				
18.483	NW8-1	± Grd (-20V)	E1-A4	BLK 16		
18.484	2	+40V (Reg)	C5 (+)	WHT-RED-RED 22		
	3	+20V (Reg)	XQ3-3	WHT-RED-ORN		
	4	36V AC (+40)	T1-9	WHT-RED-RED		
	5	39V AC (+20)	T1-8	WHT-RED-ORN		
	6	39V AC (+20)	T1-6	WHT-RED-ORN		
	7	36V AC (+40)	T1-11	WHT-RED-RED		
	8	+20V (Unreg)	R5-1	WHT-RED-ORN		
	9	+40V (Unreg)	E9	WHT-RED-RED		
	10	-20V (Unreg)	R6-1	WHT-VIO-RED 22		
	11	-8V	P4-20	WHT-VIO-BLU 20	C1 (+)	BLK 20
	12	39V AC (-20)	T1-3	WHT-VIO-RED 22		
	13	15V CT(-8)	T1-16	WHT-VIO-BLU 20		
	14	15V CT(-8)	T1-14	WHT-VIO-BLU 20		
	15	39V AC (-20)	T1-5	WHT-VIO-RED 22		
18.484	NW8-16	-8V Filter	R11-1	WHT-VIO-BLU 20	VR1-J1-D	WHT-VIO-BRN 20

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ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV NO.	
PROJECT 1887	B 026 158 0W

SHEET 21 OF SHEETS

NW2-J1 SUMMING RESISTOR NETWORK 26.116 -1

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.482	NW2-J1-A	10	A1-J1-13	WHT 20 *		
	B	20	A1-J1-12	RED		
	C	40	A1-J1-11	BRN		
18.482	D	80	A1-J1-10	BLK		
	E	Summing Junc.	A1-J1-1	COAX 6 *	NW7-J1-17	COAX 18 *
18.482	F	-1 Digit	A6-J1-K	YEL		
18.483	H	Input	NW7-J1-20	COAX 20		
	J	Key				
18.484	K	-100V Ref	S2a-NC	WHT-VIO 22		
18.483	L	± Grd	E2- G1	BLK 16		
18.482	M	100	A1-J1-9	WHT		
	N	200	8	GY		
	P	400	7	VIO		
	R	800	6	BLU		
	S	1000	5	GRN		
	T	2000	4	YEL		
	U	4000	3	ORN		
	V	8000	2	RED		
	W	1	17	GRN 20 *		
	X	2	16	RED 20 *		
	Y	4	15	BRN 20 *		
18.482	NW2-J1-Z	8	A1-J1-14	BLK 20 *		
	*	COAX #6 Shield	— SEE NOTE 1			
	*	COAX #18 Shield				

All Shields to be tied together with (1) Lead going to NW2-J1-L.

*Run as direct as possible in separate cable

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ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO	
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PROJECT 1887	B 026 158 0W

SHEET 22 OF SHEETS

S2 INTERNAL/EXTERNAL REFERENCE

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
		S2 INTERNAL /EXTERNAL REFERENCE				
18.484	S2a-C	-100V Ref	NW6-4	WHT-VIO 22	P2-2	WHT-VIO 22
18.484	NC	-100V Ref	NW2-J1-K	WHT-VIO 22	S2b-C	BUS
	S2a-NO	HQ Grd	R13	Seg Sht 2		
18.484	S2b-C	-100V Ref	S2a-NC	BUS	NW6-6	WHT-VIO 22
	NC					
	S2b-NO	Ext Ref	J2-A	WHT-VIO 22		
		S3 RANGE				
18.483	S3-1	± Grd	C4 (+)	BLK 16		
18.481	2	Remote	P4-3	ORN		
	3	Auto	A11-J1-F	YEL		
	4					
	5	100V	K3-14	BLU	A11-J1-L	BLU
	6	10V	P4-6	VIO		
18.481	7	1V	A11-J1-K	GRN		
	8					
	S3-9					
		S8 INPUT Z				
	S8-1					
——,18.483	2	Unl'd 10V	NW1-9	COAX 30	NW7-J1-15	COAX 16
18.483	3	Input 10V	NW7-J1-14	COAX 15		
	4					
	5	Unl'd 1V	NW1-7	COAX 31		
18.483	S8-6	Input 1V	NW7-J1-12	COAX 14		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

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REV. NO.
PROJECT 1887 B 026 158 0W
SHEET 23 OF SHEETS

* See Detail "B" on Sheet 3 for critical coax. shield terminations.

S4 POWER S5,S7 FUNCTION SW						
HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	S4-1	115V AC (On)			XF1-2	BLK (T #2)
	2	115V AC (Off)			E3	RED (T #2)
	3	Input	K 2-11	COAX 24		
		Coax 24 Shield	R1-3	BLK 20		
	4	Input	K2-5	COAX 25		
		Coax 25 Shield	R1-3	BLK 20		
——,18.483	5	Input	J1-1	COAX 26	P4-29	COAX 38
	5	Input	*	COAX 26 Shield	*	COAX 38 Shield
	6	115V AC (On)				
	-7	115V AC (Off)				
	S4-8	Grd	R1-3	BUS		
	S5,S7 FUNCTION SW					
	S5-1					
	-2					
18.482	-3	Ext. (Cycle Command)	P4-8	GRY		
	-4					
18.482	-5	Cycle Command	A6-J1-U	YEL		
	-6					
18.483	-7	± Grd	C4 (+)	BLK 22		
	-8					
	-9					
18.482	-10	Hold	A6-J1-D	YEL		
18.484	-11	Int (+12V)	VR1-J1-S	WHT-RED-ORN 22		
	S5-12					
18.484	S7-7	-12V	VR1-J1-P	WHT-VIO-ORN 22		

ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
SHT. NO.	
SIZE	
REV NO.	
PROJECT 1887	B 026 158 0W
SHEET 24 OF SHEETS	

E1, ± GROUND E2, H.Q. GRD

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.483	E1-A1	(-20V)	C4 (+)	BLK 16		
18.483	2	(Power Supply)	VR1-J1-Z			
18.481	3	(Output)	P1-47			
18.483	4	(Rect. Network)	NW8-1			
	5	(Prog)	A6-J1-Z			
	6	(Inter. Block)	E2-F2			
	7	(C.T. -220)	T1-18			
	8	(Transformer)	T1-20			
	9	(+20V)	XQ4-3			
18.483	-A10	(6.3V AC Ret)	T1-13			
18.483	2	(C.T. -8V)	C1 (+)			
18.483	E1-B3	± Grd	E11	BLK 16		
18.483	E1-B10	Function Grd	P4-45	BLK 18		
		E2 H.Q. GROUND				
	E2-A1	AR1-J1-B	Coax 5 Shield	BLK 20		
18.483	A2		C6-2	BLK 20		
	A3					
	B1	"A" (DC Ampl)	AR1-J1-N	BLK-WHT 16		
	B2	"B" (DC Ampl)	AR1-J1-M	BLK-WHT 16		
	B3	NW7-J1-20	Coax 20 Shield	BLK 20		
	C1	Ref Ampl	AR2-J1-Z	BLK-WHT-16		
	C2	± Grd (Junct)	E5	BLK 16		
	C3	NW7-J1-19	Coax 12 Shield	BLK 20		
	D1	"B" (DC Ampl)	AR1-J1-E	BLK 16		
	D2	"A" (DC Ampl)	AR1-J1-Y	BLK 16		
	D3					
	E1	Zero Set	R1-3	BLK 16		
	E2	Input "B" and FB	E6	BLK 16		
	E3	NW7-J1-18	Coax 19 Shield	BLK 20		
	F1	Bal POT "A"	R3-3	BLK 16		
	F2	Inter. Block	E1-A6	BLK 16		
	F3	NW7-J1-16	Coax 17 Shield	BLK 20		
	G1	Sum. Res.	NW2-J1-L	BLK 16		
18.483	G2	Ref. Amp	AR2-J1-J	BLK 16		
	G3	NW7-J1-15	Coax 16 Shield	BLK 20		
	H1	AR1-J1-V	Coax 3 Shield	BLK 20		
	H2					
18.483	H3	± Grd	NW7-J1-Y	BLK 16		
18.481	J1	Function Grd	P4-44	BLK-WHT 16		
	J2	NW7-J1-14	Coax 15 Shield	BLK 20		
	J3	NW7-J1-12	Coax 14 Shield	BLK 20		
	K1					
	K2	NW7-J1-9	Coax 1 Shield	BLK 20		
	K3	NW7-J1-9	Coax 13 Shield	BLK 20		
	L1					
18.482	L2	H.Q. Grd (Comp)	A1-J1-35	BLK-WHT 20		
18.482	L3	± Grd (Comp)	A1-J1-39	BLK 20		
	M1					
	M2	Conn. Grd	J1-2	Coax 41		
	M3	Conn. Grd	P4-30	Coax 40		
	N1					
	N2					
	N3					
	P1					
	P2					
	P3					
	R1					
	R2					
	E2-R3					

NOTES:

1. All leads connected to E1 and E2 Connectors are to be terminated into Taper Pins.

USE: Item 181 for #20 AWG Leads.
Item 183 for #16 AWG leads.

* See detail "B" on sht 3 for critical coax shield terminations.

ELECTRONIC ASSOCIATES, INC.
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SHT. NO.	
SIZE	
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PROJECT 1887	B 026 158 OW

SHEET 25 OF SHEETS

E2 H.Q. GROUND (Cont'd) F3,4 - Etc.

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	E2-S1					
	S2					
	S3					
	T1					
	T2					
	T3					
	U1					
	U2					
	U3					
	V1					
	V2					
	V3	6.3V AC (TH1)(-)(Ret)	T1-13	SHU 3 Shield	Al-TH1 (-)	(See Sht. 2)
18.483	W1	6.3V AC (TH1)(+)(Hot)	T1-12	SHU 3	Al-TH1 (+)	
	W2					
	E2-W3					
	E3	115V AC (Hot)	S4-2	RED (T #2)	T1-2C	RED (T #1)
	E4	115V AC (Com)	T1-1	BLK (T #1)	P3-9 *	
18.481	E4	115V AC (Com)	P4-42	WHT 16		
	E4 Lug	115V AC Earth Grd	T #1	Shield	T #2	Shield
—;18.481	E4 Lug	115V AC Earth Grd	P3-5 *		P4-43	GRN 16
18.483	E5	± Grd	E2-C2	BLK 16		
	E5	± Grd	J2-A	BLK 20		
	E5					
	E5 Lug	± Grd (Chassis)	E10	BLK 20		
18.483	E6	± Grd (Input)	E2-E2	BLK 16	K3-11	COAX 29 Shield
18.482	E7	-8V Grd	P4-15	BLK 22		
18.482	E8	± Grd (± Ind)	P4-16	BLK 22		
18.484	E9	+40V (Output)	NW8-9	WHT-RED-RED 22		
	E10	± Grd (Chassis)	E5 Lug	BLK 20		
18.483	E11	± Grd	E1-B3	BLK 16		
18.483	E12	Full Scale Adj	NW7-J1-18	COAX 19		SD-BUS
	E13	Full Scale Adj	XK1	COAX 42		SD-BUS
		Coax 42 Shield	**			

* = RETMA Color Leads of Power Cord
(0) Black - AC Line (Hot)
(5) Green - Earth Ground
(9) White - AC Line (Common)

** Jumper Coax 42 Shield to Coax 19 Shield.

5

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO	
SIZE	
REV NO	
PROJECT 1867	B 026 156 0W

SHEET 26 OF SHEETS

* See detail "B" on Sheet 3 for critical coax shield terminations.

T1 - TRANSFORMER, POWER

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION		COLUMN 2 WIRE
	T1-1	115V AC Com	E4	BLK (T#1)	B1-2		BLK (T#3)
	-1	115V AC Com	T1-2A	BUS #20			
	2A	115V AC	T1-1	BUS #20			
	2B	115V AC			B1-1		RED (T#3)
	2B	115V AC	T1-2C	BUS #20			
	2C	115V	T1-2B	BUS #20	E3		RED (T#1)
18.484	3	39V AC (-20)	NW8-12	WHT-VIO-RED 22			
	4						
	5	39V AC (-20)	NW8-15	WHT-VIO-RED 22			
	6	39V AC (+20)	NW8-6	WHT-RED-ORN 22			
	7						
	8	39V AC (+20)	NW8-5	WHT-RED-ORN 22			
	9	36V AC (+40)	NW8-4	WHT-RED-RED 22			
	10						
18.484	11	36V AC (+40)	NW8-7	WHT-RED-RED 22			
18.483	12	6.3V AC (Vib Drive)	AR1-J1-F	SHU 1	AR2-J1-A		SHU 2
18.483	12	6.3V AC (Vib Drive)	E2-W1	SHU 3			
	13	Vib Drive Ret	AR1-J1-H	SHU 1 Shield	AR2-J1-B		SHU 2 Shield
18.483	13	Vib Drive Ret	E2-V3	SHU 3 Shield	E1-A10		BLK 16
18.484	14	15V	NW8-14	WHT-VIO-BLU 20			
	15	C.T. (-8)					
18.484							
18.484	16	15V AC (-8)	NW8-13	WHT-VIO-BLU 20			
18.484	17	220V AC (-110)	AR2-J1-D	WHT 22			
18.483	18	C. T. Grd (-110)	C2 (+)	BLK 16	NW6-8		BLK 16
18.483	18	C. T. Grd (-110)	E1-A7	BLK 16			
18.484	19	220V AC (-110)	AR2-J1-E	WHT			
18.483	T1-20	Transformer Grd	E1-A8	BLK 16			
	J1-1	Input (F.P.)	S4-5	COAX 26		*	COAX 26 SHIELD
	J1-2	Conn. Grd	E2-M2	COAX 41		*	COAX 41 SHIELD
	J2-C	Ext. Ref	S2b-NO	WHT-VIO 20			
	J2-A	Conn. Grd	E5	BLK 20	R13		See Sht 2
	J3-1	Input (R.P.)	P4-29	COAX 27		*	COAX 27 SHIELD
	J3-2	Conn. Grd	P4-30	COAX 39		*	COAX 39 SHIELD

5

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV NO.	
PROJECT 1887	B 026 158 0W

SHEET 27 OF SHEETS

XK1, SIGN SWITCHING

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.484	XK1-1	Relay Coil (-12V)	XQ1-3	WHT-VIO-ORN 22		
	2					
	3					
18.482	4	Relay Coil	A6-J1-F	BLU		
	5	NC (-Ind)	DS5-10	BLK		
	6					
	7	NO (+ Ind)	DS5-1	BRN		
	8	NC (-Relay)	A6-J1-Y	YEL		
	9	Arm, Relay	A6-J1-M	YEL		
18.482	10	NO (+Relay)	A6-J1-V	YEL		
	11	Ampl Out "B"	XK1-14	BUS		
18.483	12	Full Scale Adj	XK1-15	BUS	E13	COAX 42
	13	Ampl Out "A"	XK1-16	BUS		
	14	Ampl Out "B"	XK1-11	BUS	XK3-11	COAX 29
	15	Arm (F.S. Adj)	XK1-12	BUS		
18.483	XK1-16	Ampl Out "A"	XK1-13	BUS	AR1-J1-B	COAX 5

K2 AUTO RANGE SWITCHING

	K2-1	NO (Arm)	K3-5	BUS 20		
	2					
	3	NC (Arm)	K3-2	BUS 20		
	4	NO (Arm)	K3-8	BUS 20		
	5	Arm (Input)	S4-4	COAX 25		
	6					
	7	NO	K3-10	BUS 20		
	8	Arm (Input "B")	NW1-5	BUS 20		
	9	NC	K3-12	BUS 20		
	10	10V/1V Input	NW1-3	BUS 20		
	11	Input	S4-3	COAX 24		
	12	NC (1000V/100V Inp)	NW1-1	BUS 20		
18.484	13	Relay Coil (-24V)	K3-13	BUS 20	R6-2	WHT-VIO 22
18.483	K2-14	Relay Drive	A11-J1-J	BLU		

K3 AUTO RANGE SWITCHING

18.481	K3-1	Dec Ind (100V)	DS3-11	WHT-VIO		
	2	Arm (NC)	K2-3	BUS 20		
18.481	3	Dec.Ind (1000V)	DS4-11	WHT-GY		
18.481	4	Dec. Ind (10V)	DS2-11	WHT-RED		
	5	Arm (NO)	K2-1	BUS 20		
18.481	6	Dec. Ind (1V)	DS1-11	WHT-BRN		
	7	10V Unl'd Input	NW1-8	BUS 20		
	8	Arm (NO)	K2-4	BUS 20		
	9	1V Unl'd Input	NW1-6	BUS 20		
	10	NO	K2-7	BUS 20		
	11	Output "B"	NW1-4	BUS 20	XK1-14	COAX 29
		COAX 29 Shield	E6			
	12	NC	K2-9	BUS 20		
	13	Relay Coil (-24V)	K2-13	BUS 20		
18.483	K3-14	Relay Drive	S3-5	BLU		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.
SIZE
REV. NO.
PROJECT 1887 B 026 158 0W
SHEET 28 OF SHEETS

* See detail "B" on Sheet 3 for critical coax shield terminations.

R1, 2, 3, 5, 6, 8 and R11

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.484	R1-1	Zero Set	NW6-5	WHT-VIO 22		
18.482	2	Zero Set	J1-J1-34	GRN		
18.483*	R1-3	± Grd	E2-E1	BLK 20	*	COAX 26 Shield
	R1-3	± Grd	S4-8	BUS	*	COAX 38 Shield
		COAX 24 Shield	R1-3	BLK-20		
		COAX 25 Shield	R1-3	BLK-20		
18.484	R2-1	-20V Output	R3-1	BUS	P2-5	WHT-VIO-RED 22
18.482	2	Bal Pot "B"	AR1-J1-R	YEL		
	R2-3	± Grd	R3-3	BUS		
18.484	R3-1	-20V Output	VR1-J1-N	WHT-VIO-RED 22	R2-1	BUS
18.482	2	Bal Pot "A"	AR1-J1-K	YEL		
18.483	R3-3	± Grd	R2-3	BUS	E2-F1	BLK 16
18.484	R5-1	+20V	NW8-8	WHT-RED-ORN 22		
18.484	R5-2	+20V	C3 (-)	WHT-RED-ORN 22	XQ4-1	WHT-RED-ORN 22
18.484	R6-1	-20V	NW8-10	WHT-VIO-RED 22		
18.484	R6-2	-20V	C4 (-)	BUS 20	XQ2-1	WHT-VIO-RED 22
18.484	R6-2	-20V	K2-13	WHT-VIO 22		
18.484	R8-1	+2V Output	VR1-J1-T	WHT-RED-BLU 22	NW7-J1-C	WHT-RED-BLU 22
18.484	R8-2	+20V Output	C3 (+)	WHT-RED-ORN 22	XQ3-3	WHT-RED-ORN 22
18.484	R11-1	Drop. Resis. (-8V)	NW8-16	WHT-VIO-BLU 20	C1 (-)	WHT-VIO-BLU 20
18.484	R11-2	-8V Unreg	XQ5-1	WHT-VIO-BLU 20		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.
SIZE
REV. NO.
PROJECT 1887 B 026 158 0W
SHEET 29 OF SHEETS

XQ1,2,3,4 XF1

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.484	XQ1-1	-20V (Collector)	VR1-J1-Y	WHT-VIO-RED 22		
↕	XQ1-2	-12V (Base)	VR1-J1-U	WHT-VIO-ORN 22		
18.484	XQ1-3	-12V Output	VR1-J1-P	WHT-VIO-ORN 22	XK1-1	WHT-VIO-ORN 22
18.484	XQ2-1	Collector (-20)	R6-2	WHT-VIO-RED 22	VR1-J1-X	WTH-VIO-RED 22
↕	XQ2-2	Base (-20)	VR1-J1-W	WHT-VIO-RED 22		
18.484	XQ2-3	-20V Output	VR1-J1-N	WHT-VIO-RED 22	AR1-J1-A	WHT-VIO-RED 22
18.484	XQ3-1	Collector (+40)	C5 (-)	WHT-RED-RED 22	VR1-J1-B	WHT-RED-RED 22
↕	XQ3-2	Base (+40)	VR1-J1-A	WHT-RED-RED 22		
	XQ3-3	+20V Output	R8-2	WHT-RED-ORN 22	VR1-J1-M	WHT-RED-ORN 22
18.484	XQ3-3	+20V Output	NW8-3	WHT-RED-ORN 22		
18.484	XQ4-1	Collector (+20)	R5-2	WHT-RED-ORN 22	VR1-J1-L	WHT-RED-ORN 22
18.484	XQ4-2	Base (+20)	VR1-J1-K	WHT-RED-ORN 22		
18.483	XQ4-3	Emitter Grd	E1-A9	BLK 16		
18.484	XQ5-2	-8 Reg (Base	VR1-J1-J	WHT-VIO-BLU 20		
18.484	XQ5-1	-8V Unreg (Collector)	R11-2	WHT-VIO-BLU 20		
18.484	XQ5-3	-8V Reg (Emitter)	A10-J1-A	WHT-VIO-BLU 20		
—,18.481	XF1-1	115V AC (Hot)	P3-0	* (0) BLK	P4-41	BLK 16
	XF1-2	115V AC	S4-1	BLK (T#2)		

* = RETMA Color Leads of Power Cord:
(0) Black - AC Line (Hot)
(5) Green - Earth Ground
(9) White - AC Line (Common)

3

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV NO	
PROJECT 1887	B 026 158 0W

SHEET 30 OF SHEETS

C1, 2, 3, 4, 5, C6 B1 and TH1

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
18.483	C1 (+)	Filter Grd	E1-B2	BLK 16	A8-J1-M	BLK 16
18.484	C1 (+)	Filter Grd	NW8-11	BLK 20	A11-J1-W	BLK 16
18.484	C1 (-)	-8V Filter	R11-1	WHT-VIO-BLU 20		
	C2 A (+)	Filter Grd				
18.483	C2 B (+)	Filter Grd		Bus #20	T1-18	BLK 16
18.484	C2 (-)	-110V Filter	AR2-J1-K	WHT 22		
18.484	C3 (+)	+20V Output	R8-2	WHT-RED-ORN 22		
18.484	C3 (-)	+20V Filter	R5-2	WHT-RED-ORN 22		
18.483	C4 (+)	± Grd	S3-1	BLK 16	E1-A1	BLK 16
18.483	C4 (+)	± Grd	A2-J1-P	BLK 16	S5-7	BLK 22
	C4 (-)	-20V Filter	R6-2	BUS		
18.484	C5 (+)	+40V Output	NW8-2	WHT-RED-RED 22	AR1-J1-J	WHT-RED-RED
18.484	C5 (+)	+40V Output	VR1-J1 E	WHT-RED-RED 22		
18.484	C5 (-)	+40V Filter	XQ3-1	WHT-RED-RED 22		
	C6-1	± Grd (Out)	See Sht. #2			
18.483	C6-2	± Grd (In)	E2-A2	BLK 20		
	B1-1	117V AC	T1-1	BLK (T #3)		
	B1-2	117V AC Com	T1-2B	RED (T #3)		

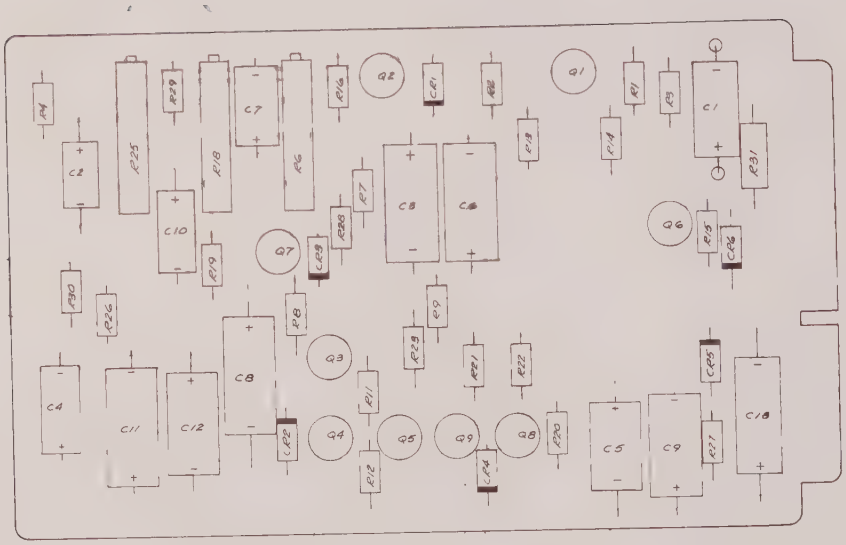
ELECTRONIC ASSOCIATES, INC.	LONG BRANCH, NEW JERSEY
SHT. NO.	
SIZE	
REV. NO	
PROJECT	1887 B 026 158 0W
SHEET 31 OF SHEETS	

26.158 1 ADDITIONS AND DELETIONS

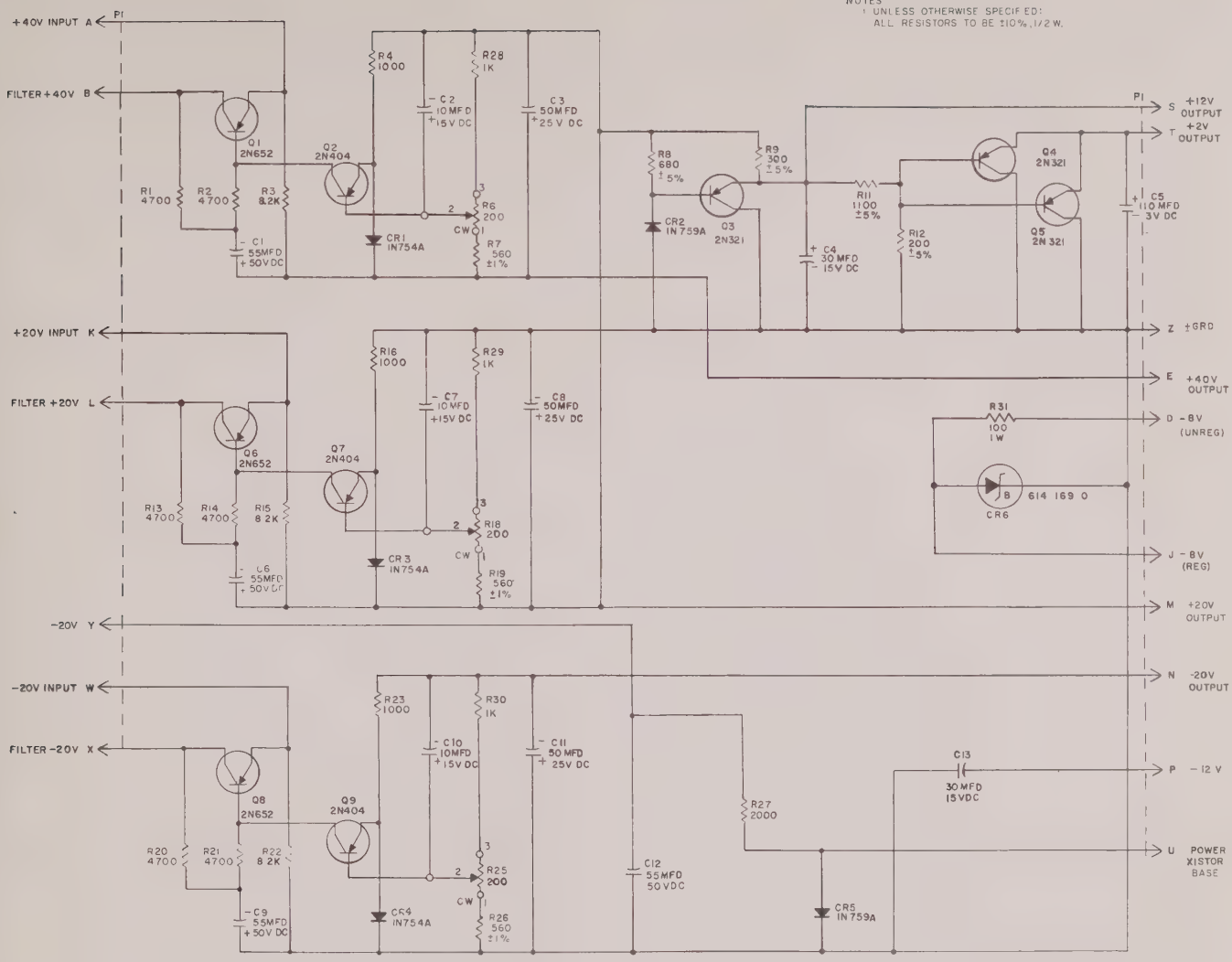
HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
		REMOVE THE FOLLOWING TERMINATIONS				
	J1-1	Input (F.P.)	S4-5	COAX 26		
	J1-2	Conn. Grd	R1-3	COAX 26 Shield		
	J3-1	Input (R.P.)	P4-29	COAX 27		
	J3-2	Conn. Grd	P4-30	COAX 27 Shield		
	P3-0	115 AC Hot	XF1-1	BLK * } A.C. Pwr. Cord		
	P3-5	Earth Grd	E4 Lug	GRN * }		
	P3-9	115 AC Com.	E4	WHT * }		
	P4-15	Dec Point Grd	P4-16	BUS		
	P4-16	± Ind Grd	P4-44	BUS		
		ADD THE FOLLOWING WIRES				
	P4-29	Input	P2-24	COAX 27		
	P4-30	Input Grd	P2-25	COAX 27 Shield		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.
SIZE
REV NO.
PROJECT 1887 B 026 15R 0W
SHEET 33 OF SHEETS



43.126-1 Power Supply Regulator, Component Layout Diagram



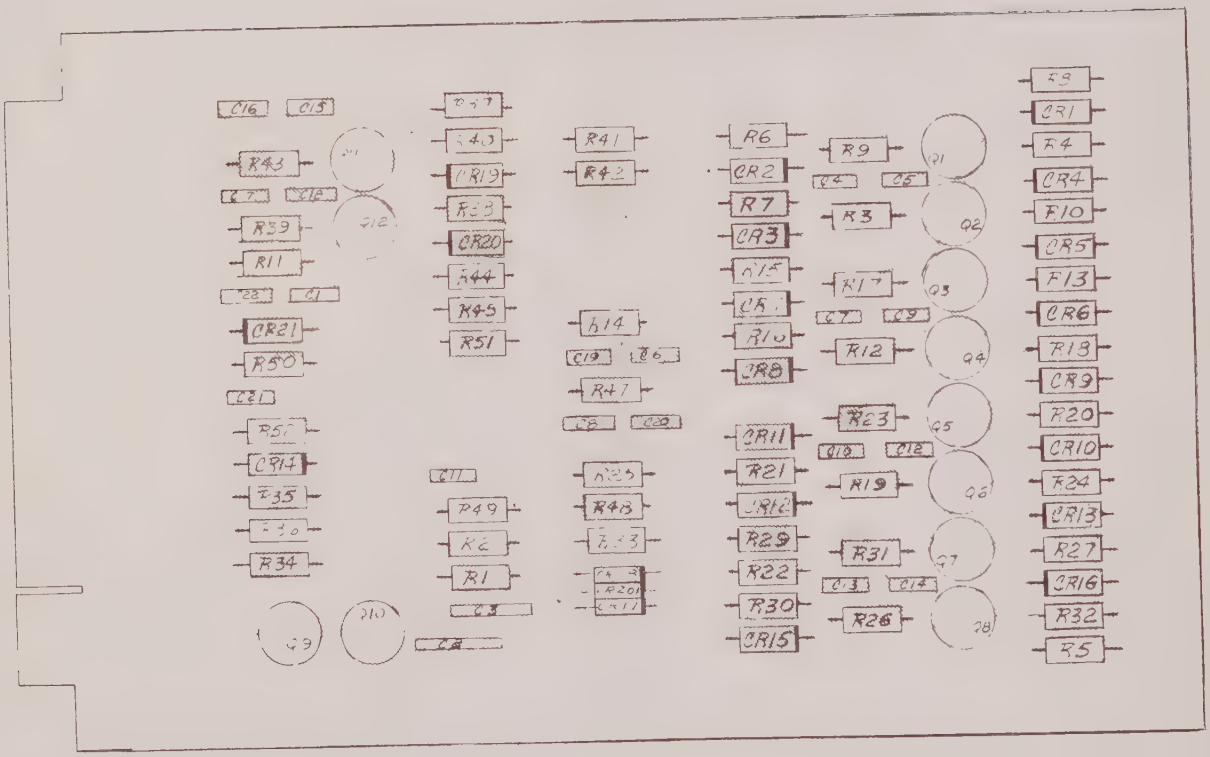
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
CAPACITANCE IS IN MMFD
RESISTANCE IS IN OHMS
TOLERANCE ON
FRACTIONS DECIMALS ANGLES
2 PLACE ± .005 ±
TOL OF MATERIAL SUPPLIED

ELECTRONIC ASSOCIATES, INC
LONG BRANCH, NEW JERSEY

SCHEMATIC
POWER SUPPLY REGULATOR
(SERIES 5001 TDVM)

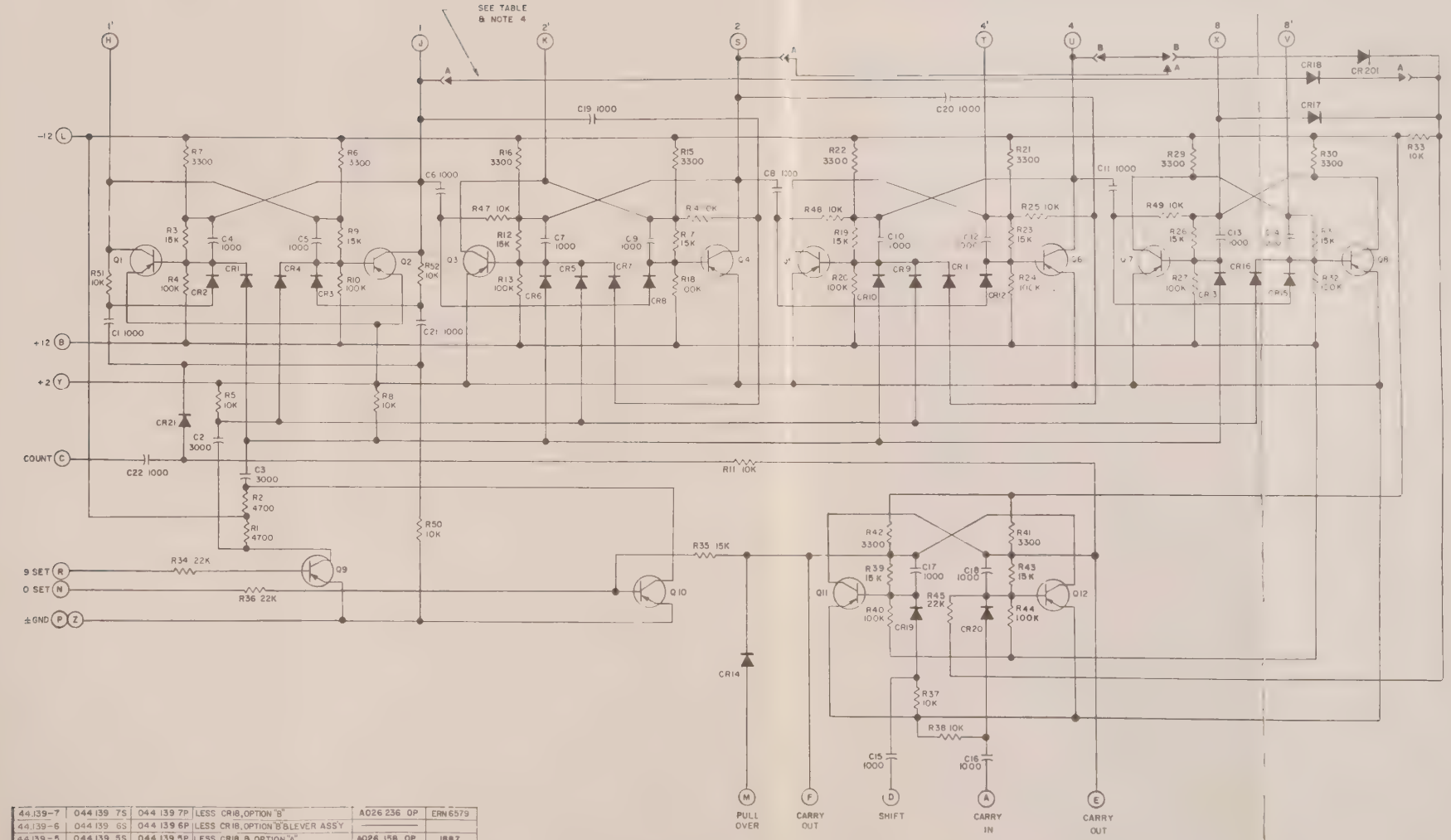
PROJECT EAN 5466 | C 043 126 05

SHEET 1 OF 1 SHEETS



44.139 Binary Coded Decade Counter, Component Layout Diagram

NOTES:
1. UNLESS OTHERWISE SPECIFIED ALL TRANSISTORS PER B686 (32 O
2. UNLESS OTHERWISE SPECIFIED ALL DIODES ARE EAI 614043 D
3. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE ±10% TOLERANCE 1/2 WATT
4. OPTIONS SHOWN ARE ALTERNATE CIRCUITRY AND/OR CIRCUIT PATHS. THEY DO NOT NECESSARILY REPRESENT PHYSICAL JUMPERS.



UNIT NUMBER	SCHEMATIC NUMBER	PARTS LIST & NEXT ASS'Y	DESCRIPTION	PARTS LIST USED ON	PROJECT NUMBER
44.139-7	044 139 7S	044 139 7P	LESS CR18, OPTION "B"	A026 236 OP	ERN6579
44.139-6	044 139 6S	044 139 6P	LESS CR18, OPTION "B" & LEVER ASS'Y		
44.139-5	044 139 5S	044 139 5P	LESS CR18 & OPTION "A"	A026 158 OP	1887
44.139-4	044 139 4S	044 139 4P	LESS CR18, OPTION "A" & LEVER ASS'Y		
44.139-3	044 139 3S	044 139 3P	LESS OPTION "B"	A026 156 OP	1423
44.139-2	044 139 2S	044 139 2P	LESS OPTION "B" & LEVER ASS'Y.		
44.139-1	044 139 1S	044 139 1P	LESS CR201 & OPTION "B"	A026 139 OP	1877
44.139	D044 139 0S	A044 139 0P	LESS CR201 OPTION "B" & LEVER ASS'Y	A026 045 OP	1969

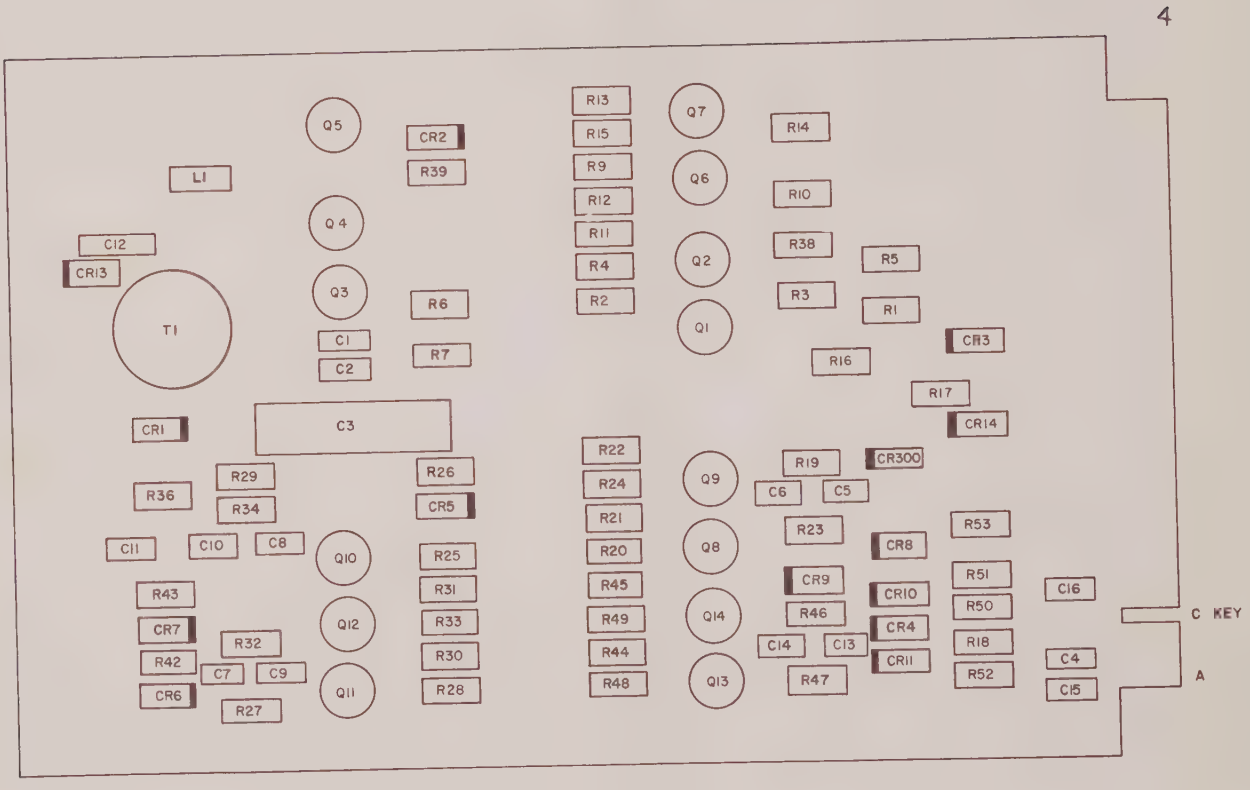
TABLE OF UNIT NUMBERS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES CAPACITANCE IS IN MMFD RESISTANCE IS IN OHMS TOLERANCE ON FRACTIONS DECIMALS ANGLES ± ± ± & TOL OF MATERIAL SUPPLIED

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SCHEMATIC DIAGRAM
BINARY CODED
DECADE COUNTER

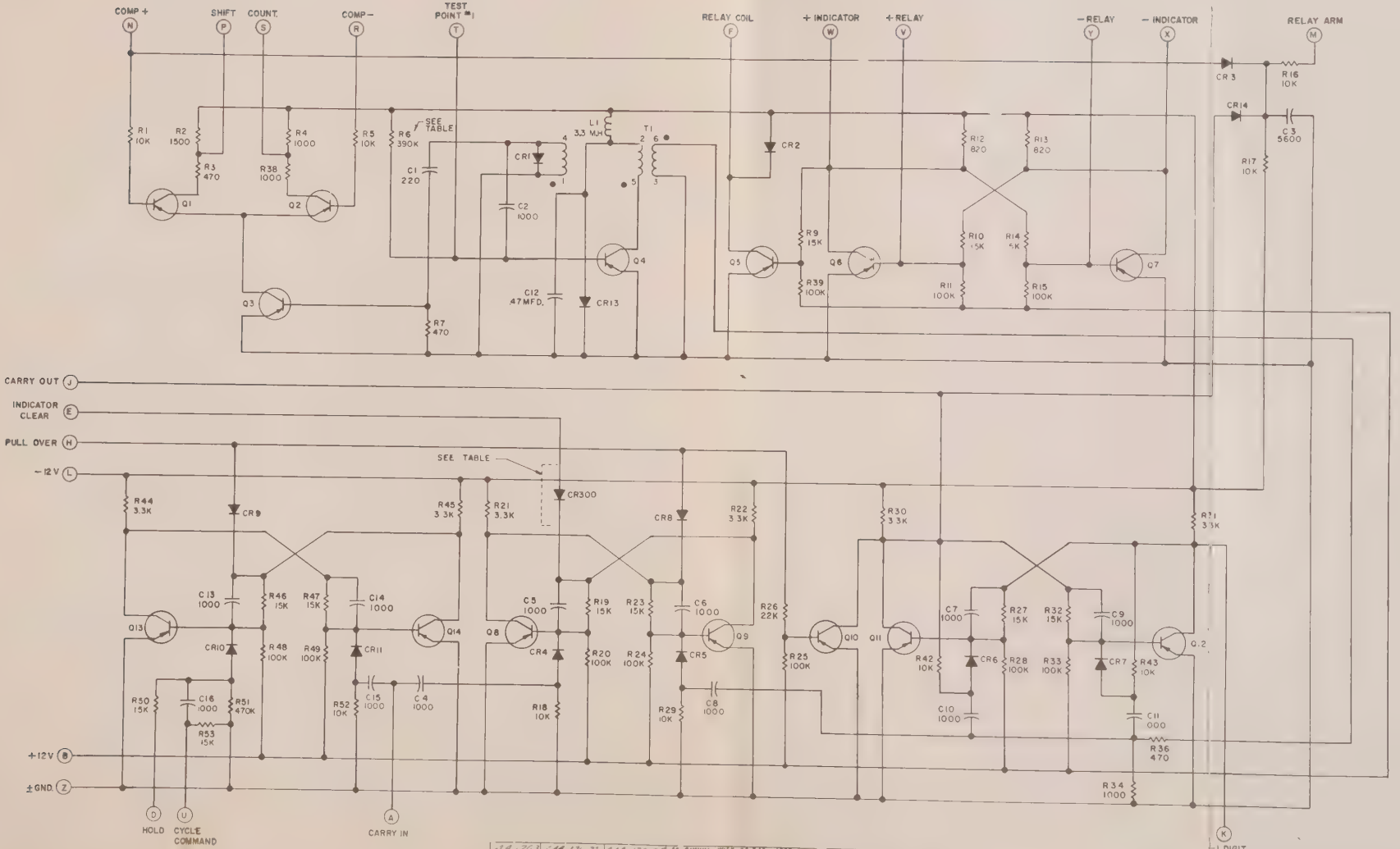
SHT NO
SIZE
REV NO
PROJECT 1969 D044 139 0S
SHEET 1 OF 1 SHEETS



44.170-4 Programmer, Component Layout Diagram

NOTES

1. UNLESS OTHERWISE SPECIFIED ALL TRANSISTORS PER 8686 032 0.
2. UNLESS OTHERWISE SPECIFIED ALL DIODES ARE 614 043 0 OR EQUAL.
3. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ±10% TOLERANCE, 1/2 W.

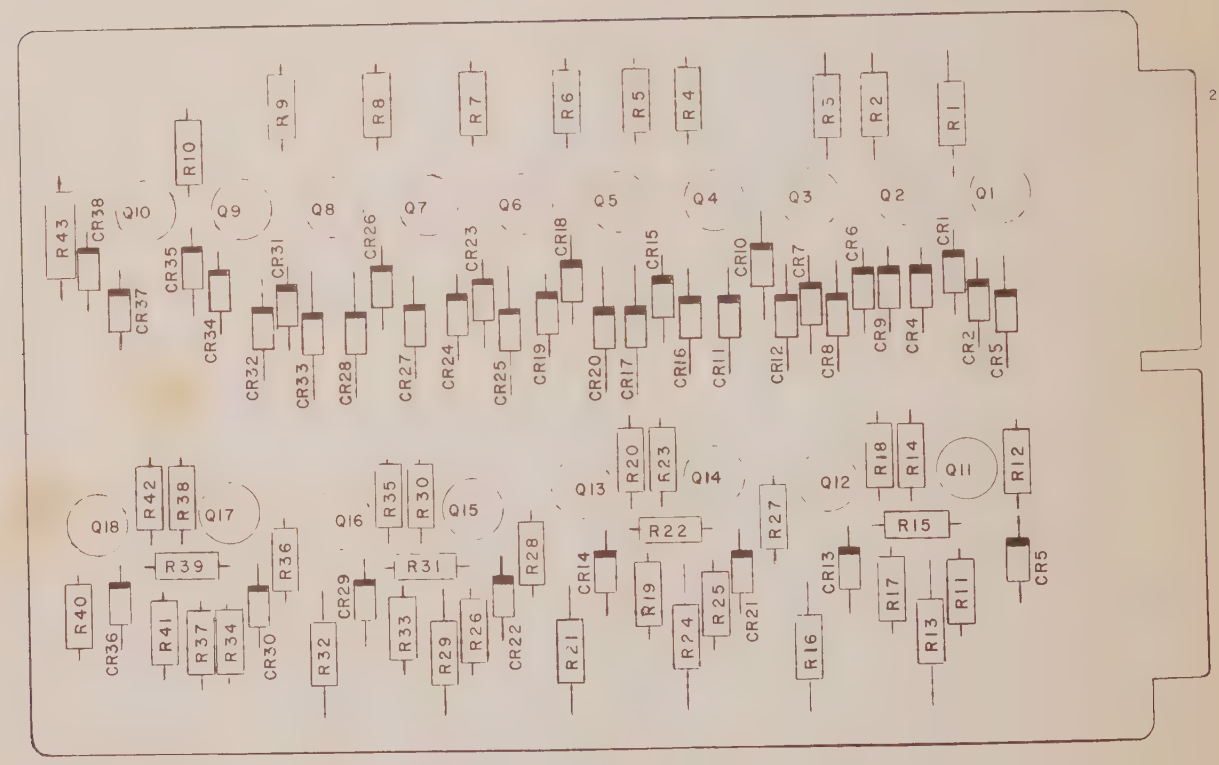


UNIT NUMBER	SCHEMATIC NUMBER	PARTS LIST & NEXT ASSY.	DESCRIPTION	PARTS LIST USED ON	PROJECT NUMBER
TABLE OF UNIT NUMBERS					
44,170 3	044 170 03	044 170 05	AS SHOWN WITH CR 300 OMITTED AND DASHED CONNECTIONS TO R 310K	4026 139 UP	1217
44,170 2	044 170 02	044 170 23	044 170 05 AS SHOWN WITH DASHED CONNECTIONS LESS CR300 R 310K		
44,170 1	044 170 01	044 170 15	044 170 05 AS SHOWN WITH DASHED CONNECTIONS LESS CR300		
" "	" "	" "	044 170 05 AS SHOWN WITH DASHED CONNECTIONS LESS CR300	1 1 15R	

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH NEW JERSEY

SCHEMATIC DIAGRAM
PROGRAMMER

SHT NO.
SIZE
REV NO.
PROJECT 1969 D044 170 0S
SHEET 1 OF 1 SHEETS



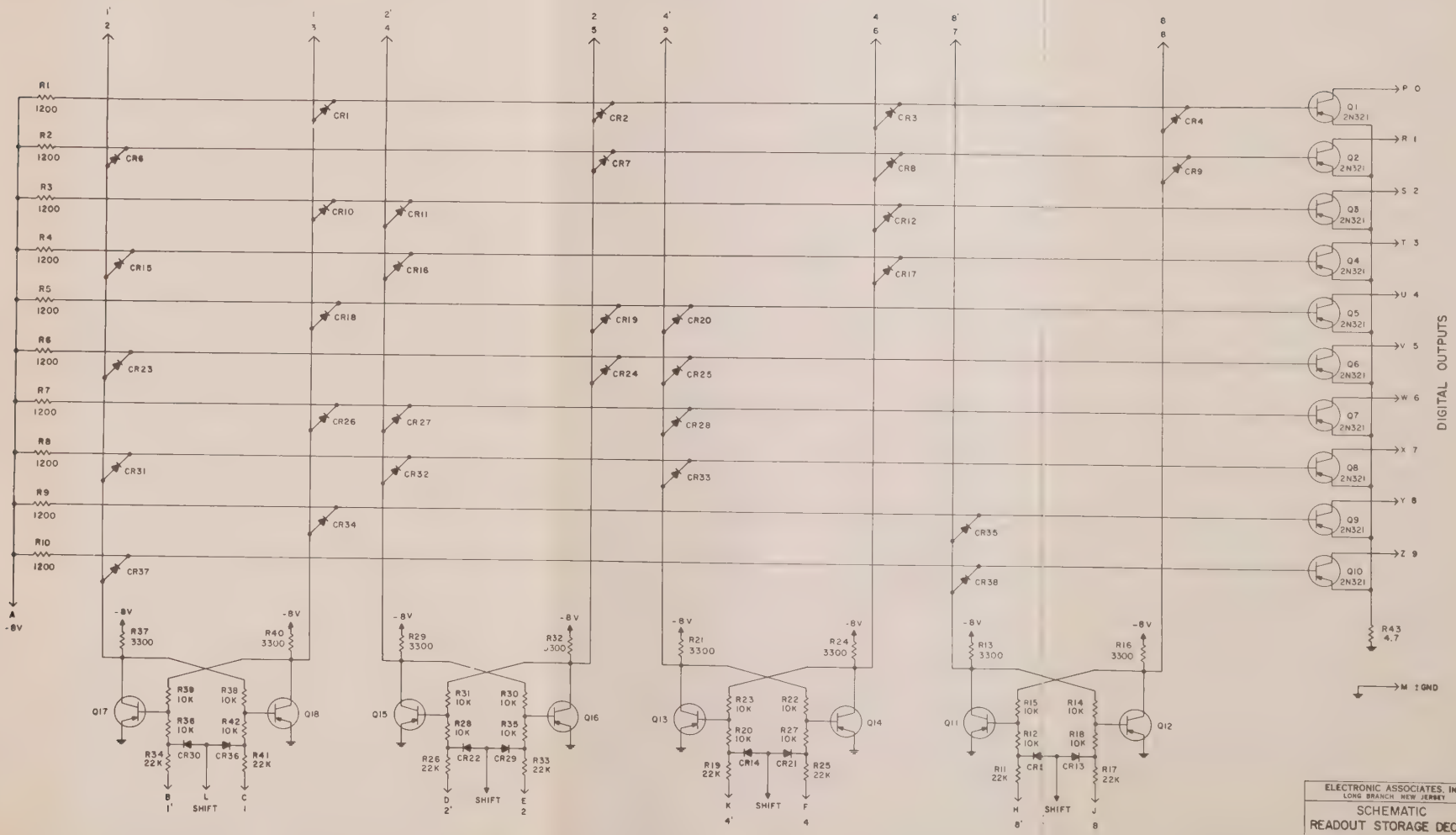
51.010 Readout Storage Decade, Component Layout Diagram

UNIT NUMBER	SCHEMATIC NUMBER	PARTS LIST & NEXT ASSY.	DESCRIPTION	PARTS LIST USED ON	PROJECT NUMBER
51.010-7	051 010 7S	051 010 7P	ELEC. THE SAME AS 51.010-6	———	———
-6	6S	6P	SHT.2 LESS R15,17,23,25,31,33,39,41	———	———
-5	5S	5P	ELEC. THE SAME AS 51.010-4	———	———
-4	4S	4P	SHT.2 LESS R11,14,19,22,26,30,34,38	———	———
-3	3S	3P	ELEC. THE SAME AS 51.010-2	———	———
-2	2S	2P	SHT 2 AS SHOWN	A026 160 0P	1728
-1	1S	1P	ELEC. THE SAME AS 51.010	A026 139 0P	1877
51 010	D051 010 0S	A051 010 0P	SHT 1 AS SHOWN	A026 048 0P	1969

TABLE OF UNIT NUMBERS

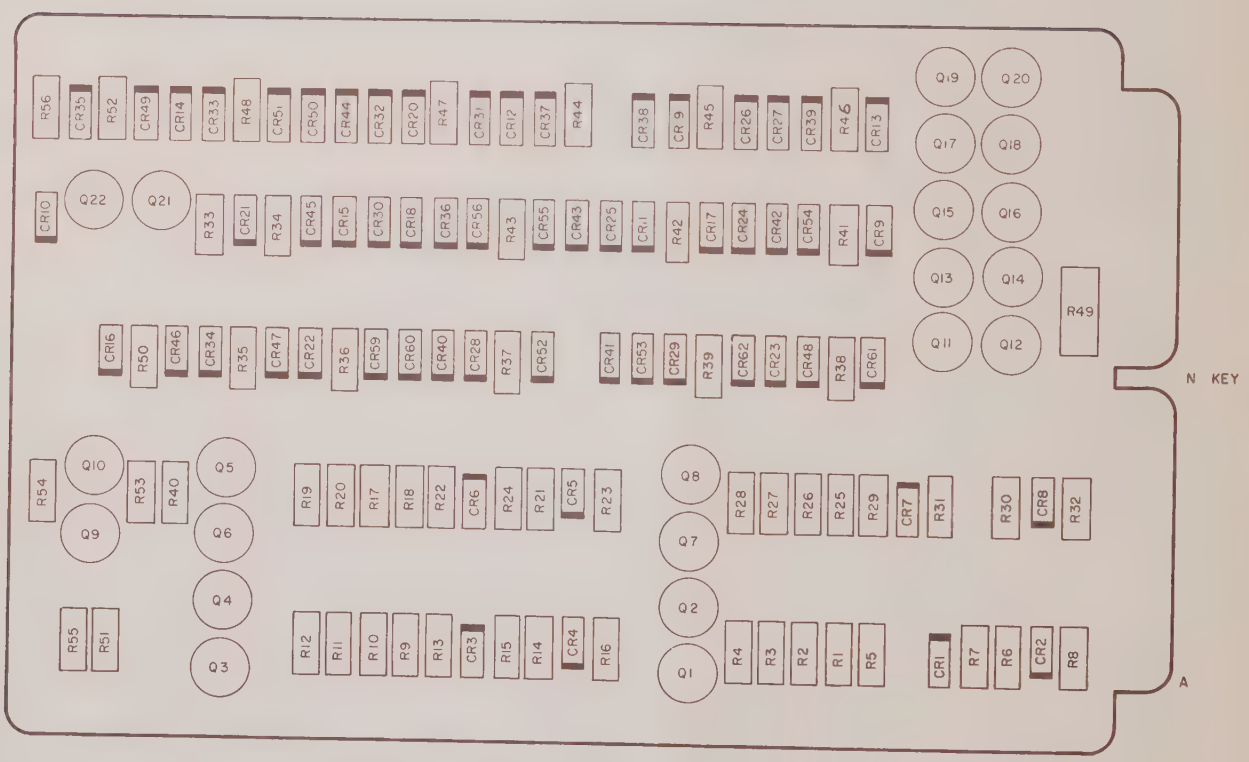
(SUPERSEDED BY -6 AND -7) DO NOT USE W/o AUTH

NOTES:
1 UNLESS OTHERWISE SPECIFIED:
ALL TRANSISTORS PER 8686 032 0
ALL RESISTORS ARE ±10% TOLERANCE, 1/2 WATT
ALL DIODES ARE EAI 614 043 0.

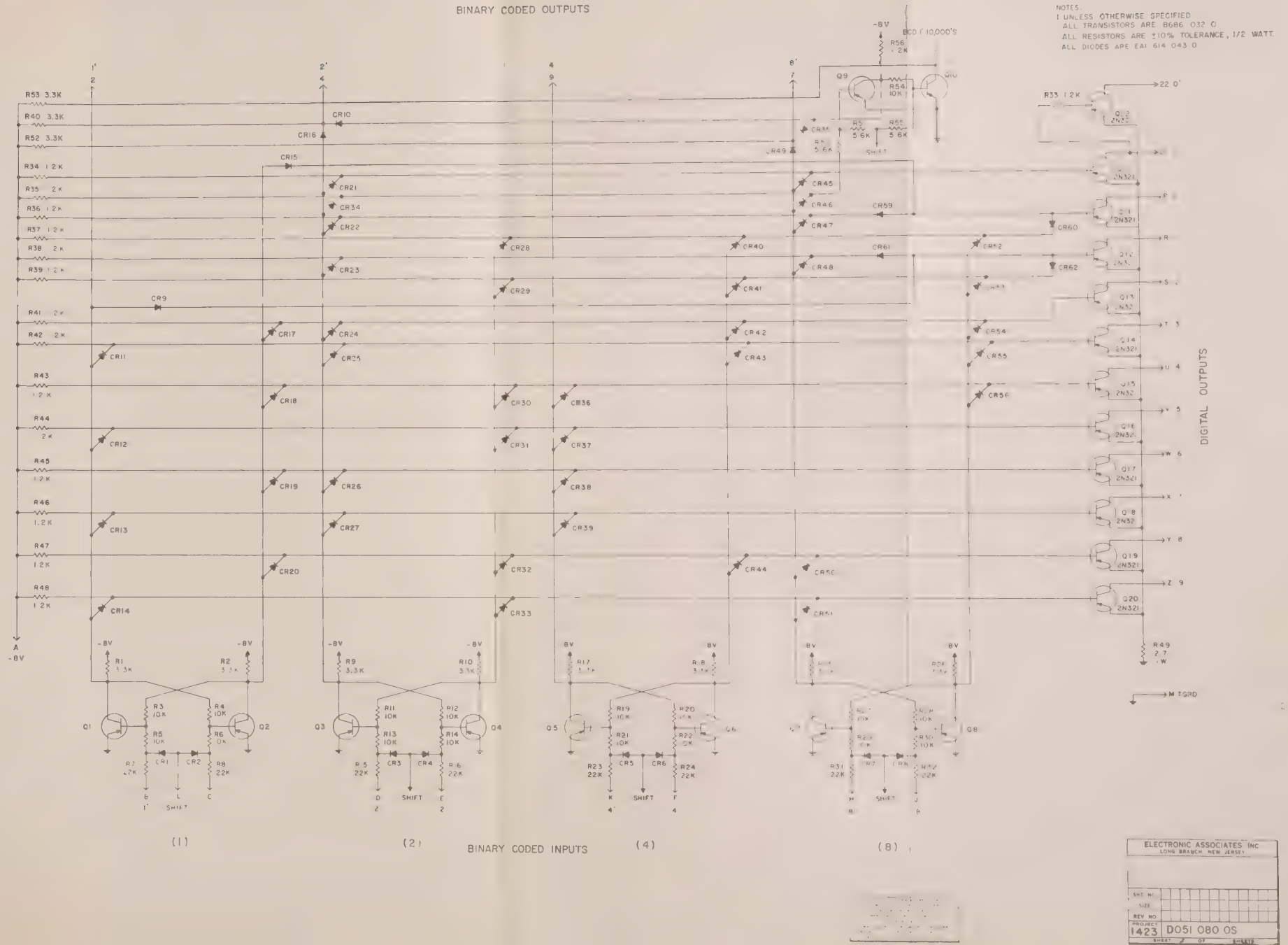


ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY
SCHEMATIC
READOUT STORAGE DECADE

SHT NO	2
SIZE	D
REV NO	1
PROJECT 1969	D051 010 0S
SHEET	OF SHEETS



51.080-5 Readout Storage Decade, Component Location Diagram


BINARY CODED OUTPUTS
NOTES.
1 UNLESS OTHERWISE SPECIFIED
ALL TRANSISTORS ARE 8686 032 0
ALL RESISTORS ARE ±10% TOLERANCE, 1/2 WATT.
ALL DIODES ARE EAI 614 043 0
BCD (10,000'S)
-8V
R56 1.2K
Q9
Q10
R54 10K
R55 5.6K
R53 3.3K
R40 3.3K
R52 3.3K
R34 1.2K
R35 2K
R36 1.2K
R37 1.2K
R38 2K
R39 1.2K
R41 2K
R42 2K
R43 1.2K
R44 2K
R45 1.2K
R46 1.2K
R47 1.2K
R48 1.2K
CR9
CR10
CR11
CR12
CR13
CR14
CR15
CR16
CR17
CR18
CR19
CR20
CR21
CR22
CR23
CR24
CR25
CR26
CR27
CR28
CR29
CR30
CR31
CR32
CR33
CR34
CR36
CR37
CR38
CR39
CR40
CR41
CR42
CR43
CR44
CR45
CR46
CR47
CR48
CR49
CR50
CR51
CR52
CR54
CR55
CR56
CR59
CR60
CR61
CR62
R33 1.2K
22 0'
Q12 2N321
Q13 2N321
Q14 2N321
Q15 2N321
Q16 2N321
Q17 2N321
Q18 2N321
Q19 2N321
Q20 2N321
R49 2.7 1W
M GRD
DIGITAL OUTPUTS
A
-8V
R1 3.3K
R2 3.3K
R3 10K
R4 10K
R5 10K
R6 10K
R7 22K
R8 22K
Q1
Q2
CR1
CR2
SHIFT
R9 3.3K
R10 3.3K
R11 10K
R12 10K
R13 10K
R14 10K
R15 22K
R16 22K
Q3
Q4
CR3
CR4
R17 3.3K
R18 3.3K
R19 10K
R20 10K
R21 10K
R22 10K
R23 22K
R24 22K
Q5
Q6
CR5
CR6
R25 10K
R26 10K
R27 10K
R28 10K
R29 22K
R30 22K
R31 22K
R32 22K
Q7
Q8
CR7
CR8
(1)
(2)
(4)
(8)
BINARY CODED INPUTS
ELECTRONIC ASSOCIATES INC
LONG BRANCH NEW JERSEY
SHT NO
SIZE
REV NO
PROJECT 1423
D051 080 05
SHEET 2 OF SHEETS

APPENDIX III

SERVICING TECHNIQUES

1. INTRODUCTION

Although servicing and troubleshooting procedures applicable to transistor circuits are similar in many ways to the techniques used with vacuum tube circuits, certain differences exist, and several extra precautions are necessary when servicing transistor circuits. The following suggestions and techniques are given to aid maintenance personnel who are not familiar with servicing transistorized equipment.

2. ETCHED CIRCUIT BOARD SOLDERING

The techniques and precautions employed while soldering any electronic equipment still apply, but there are several additional factors to be considered when working with etched circuit boards.

a. Wire leads or components fastened to the board by their leads may be replaced using the following precedures:

(1) Grip the lead to be removed with a pair of long-nose pliers (in cases where this is impossible due to extremely short or hidden leads, the component itself must be carefully grasped). While applying pressure to the lead, touch a well-tinned, small (40 watt or less), soldering iron to the fillet. If the lead does not slip out immediately, remove the soldering iron and recheck to be sure the correct fillet is being heated.

(2) Clear the excess solder from the hole by touching the iron to it briefly and either blowing the excess solder out or carefully pushing it out with a soldering aid (GC Electronics No. 9093 or equivalent).

(3) Bend the leads on the new component or jumper to fit the board connections. Insert the component, but *do not* cut the leads.

(4) With the component or jumper held in place, touch the soldering iron to the lead and allow solder to run down the lead and form a fillet. Heat should be applied to the lead only until the fillet has formed. It is not necessary to fill the hole with solder, and some components such as transistors and diodes may be damaged by prolonged application of the soldering iron.

(5) After both leads have been soldered, use a pair of diagonal cutters to cut the lead off as close to the board as possible. Use the soldering aid to carefully scrape any excess flux or solder off the board.

b. Replacing components such as transistors, relay and chopper sockets, potentiometers, or networks with multiple connections is accomplished in essentially the same manner. Removal of these components is much easier if special tips such as the Ungar Electric Tools No. 856 (5/8" dia. cup) and No. 858 (bar) are used. These tips are used for component *removal* only, and permit all leads to be freed simultaneously.

If the above procedures are strictly adhered to, no trouble with the etched conductor itself should be encountered. If, however, a conductor becomes cracked or broken it may be repaired by carefully soldering a tinned piece of bus wire over it. Again extreme care should be taken not to overheat the strip and cause it to separate from the board.

3. TRANSISTOR SERVICING

Most transistors are mechanically rugged, but they are easily damaged by excessive heat. If it becomes necessary to solder near a socket-mounted transistor, the transistor should be removed to prevent damaging it. When the transistor is soldered to the board, extreme care should be taken to prevent damage to it from overheating. Always use a small, well-tinned soldering iron and work as quickly as possible.

Transistors and small diodes which are soldered directly to the board should be removed only when there is strong reason to believe they are defective, as they are often over-heated while being removed. When soldering transistors or diodes a heat sink should be used, whenever practicable, on each lead as it is soldered. Two common methods of protecting these semiconductors from overheating while soldering are holding the lead with a pair of long-nose pliers, or clipping an alligator clip, the jaws of which have been filled with solder, on the lead.

Power transistors, which are usually used in power amplifiers and power supplies, are mounted on metal chassis plates which function as heat sinks to dissipate the heat generated during normal operation. The metal case of a power transistor is usually the collector and operates at relatively high potentials. For this reason power transistors must be mounted so that they are electrically insulated from the heat sink. At the same time, heat from the transistor must be transferred easily to the heat sink. A common method of accomplishing this is by using a mica, anodized aluminum, or fiberglass washer coated with silicon grease. The washer provides electrical insulation, and the silicone grease increases the heat conduction. When replacing a power transistor, use only a single washer, and coat both sides with silicone grease (Dow Corning No. 4 Compound or equivalent). As a final precaution before applying power to the unit, check the resistance between the body of the transistor and the heat sink to ensure that no short or high resistance leakage path exists between these points.

Diodes, electrolytic capacitors, and the transistors themselves used in transistor circuits are easily damaged by voltage overload. For this reason transistors should never be removed or inserted with power applied, and special care must be taken in the selection and use of test equipment. Signal generators commonly used in servicing vacuum tube circuits are often capable of producing enough output to overload and permanently damage the diodes, electrolytic capacitors, and transistors used in transistor circuits. Always start with the minimum output signal and slowly increase it to the desired level.

The meter used for continuity and resistance checks must be carefully chosen. Some ohmmeters use batteries with a higher voltage rating than the transistors and capacitors being checked, and will destroy them. For this reason a meter with a 1-1/2 volt battery (Triplett Model 630A or equivalent) is recommended. In order to prevent damage to the small electrolytic capacitors used in these circuits it is essential to determine the polarity of the ohmmeter leads. This may be done easily by using another meter set to a low dc scale.

4. TRANSISTOR TROUBLESHOOTING

As with any other type of electronic circuit, the first step in troubleshooting transistor circuits is a visual inspection for charred, discolored, or leaky components; broken, shorted, or loose connections; heavily tarnished or broken connectors; and physical damage to the board itself. The next step is to replace any relays, ovens, or choppers, which are socket mounted on the board, with units known to be good. This is done not only because it is fairly easy, but also because each contains mechanical moving parts which may fail due to normal wear. If the trouble is not located by either of these steps, the board may be dynamically tested by applying all supply voltages and a signal input and then checking voltages and signals on the board until the trouble is isolated. If dynamic testing is impossible due to the lack of suitable test equipment, or availibility of "down time" on the equipment in which it is used, the trouble can usually be located through resistance and continuity checks.

Refer to the schematic when making resistance checks to be sure that meter polarity is correct for any electrolytic capacitors in the circuit and that parallel dc paths are not affecting the readings. When the board is removed many components are naturally isolated by the plug or pin connections. Others are effectively isolated by capacitors in series with them. When it becomes necessary to unsolder and lift one end of a component from the board to isolate it for resistance checks, resistors should be chosen whenever possible as they are the component least likely to be damaged by the heat. In many cases, by carefully selecting the correct lead to disconnect, several components may be isolated at one time. It is not usually necessary to risk overheating a transistor by unsoldering it to make resistance checks. For example, lifting one end of the collector load resistor and one end of the emitter resistor would effectively isolate the transistor in a normal transistor amplifier stage.

Once a transistor is isolated, it may be checked using the following procedures:

a. Set the ohmmeter to a high range and connect it between the base and the collector leads; reverse the leads and note which connection caused the higher reading. This is the reverse-bias direction.

b. Connect the ohmmeter to reverse-bias the transistor and note the reading. Short the base to the emitter. The reading should decrease. Remove the short.

c. Move the lead on the base to the emitter and note the reading. Re-connect the short. The reading should increase.

This test will indicate a burnt-out transistor but not a weak or high-leakage transistor. If the transistor is still suspected, and no other troubles are found, substitute one known to be good.